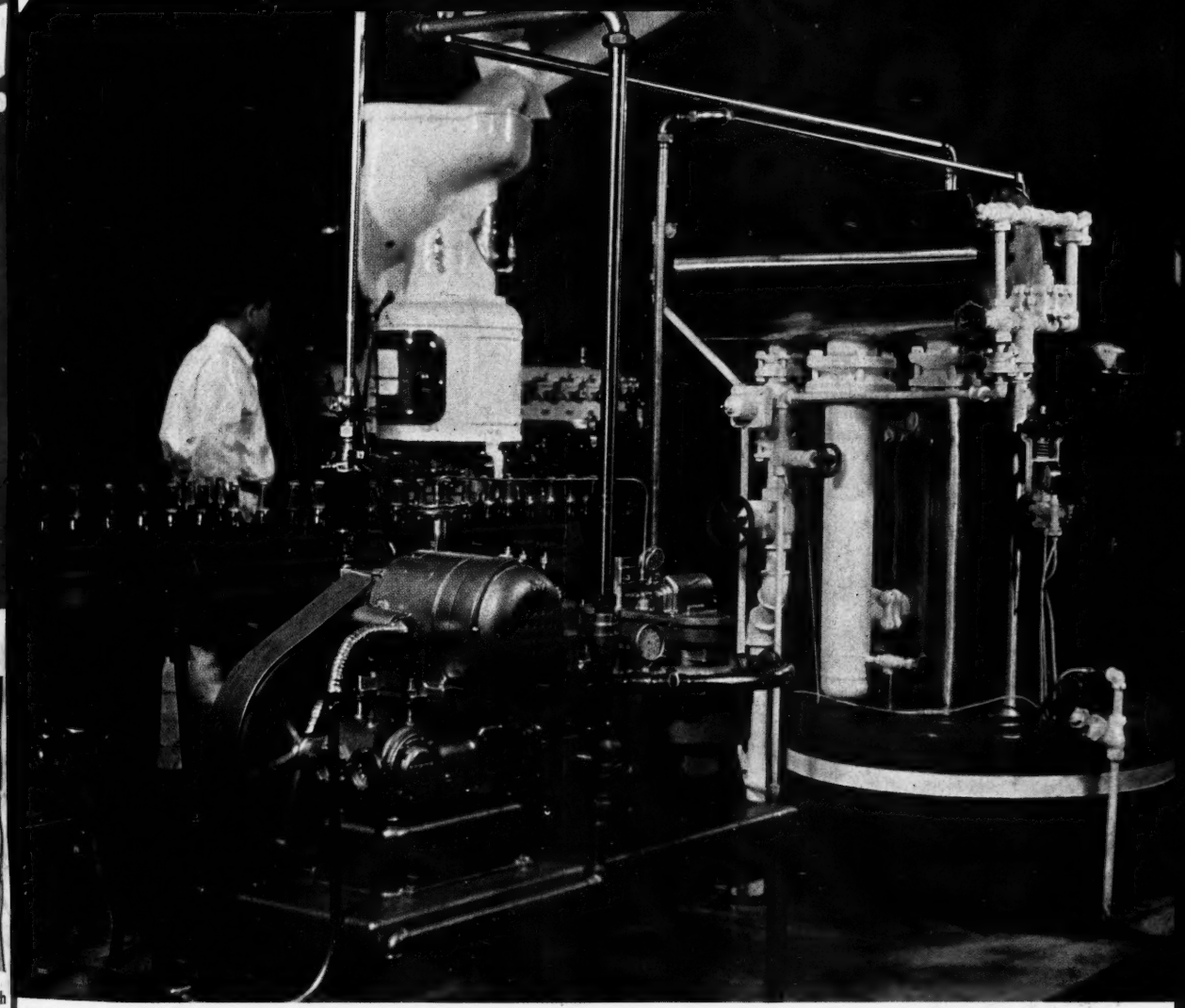
PUBLIC LIBRARY
AUG 21 1945
DETROIT

Power Plant ENGINEERING

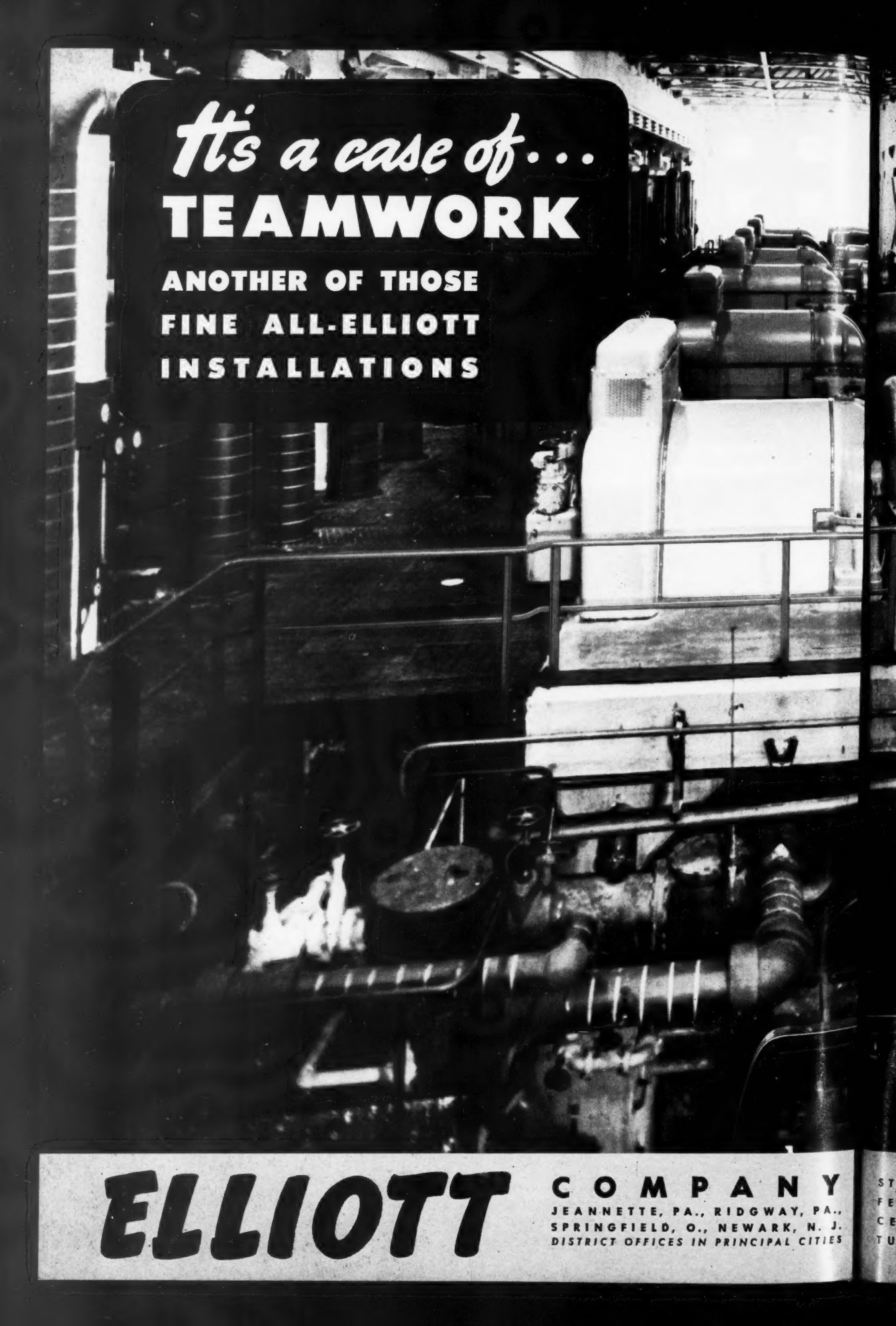


THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

AUGUST • 1945

Features

GAS TURBINES—OPERATION—COAL-BURNING • DESIGN OF SMALL POWER PLANTS • FRONT ROYAL PLANT • MYSTERY OF RASPING COMPRESSOR • CENTRIFUGAL PUMP CONTROL—VI • METAL-CLAD SWITCHGEAR INSTALLATION HINTS • • CONTENTS PAGE 5

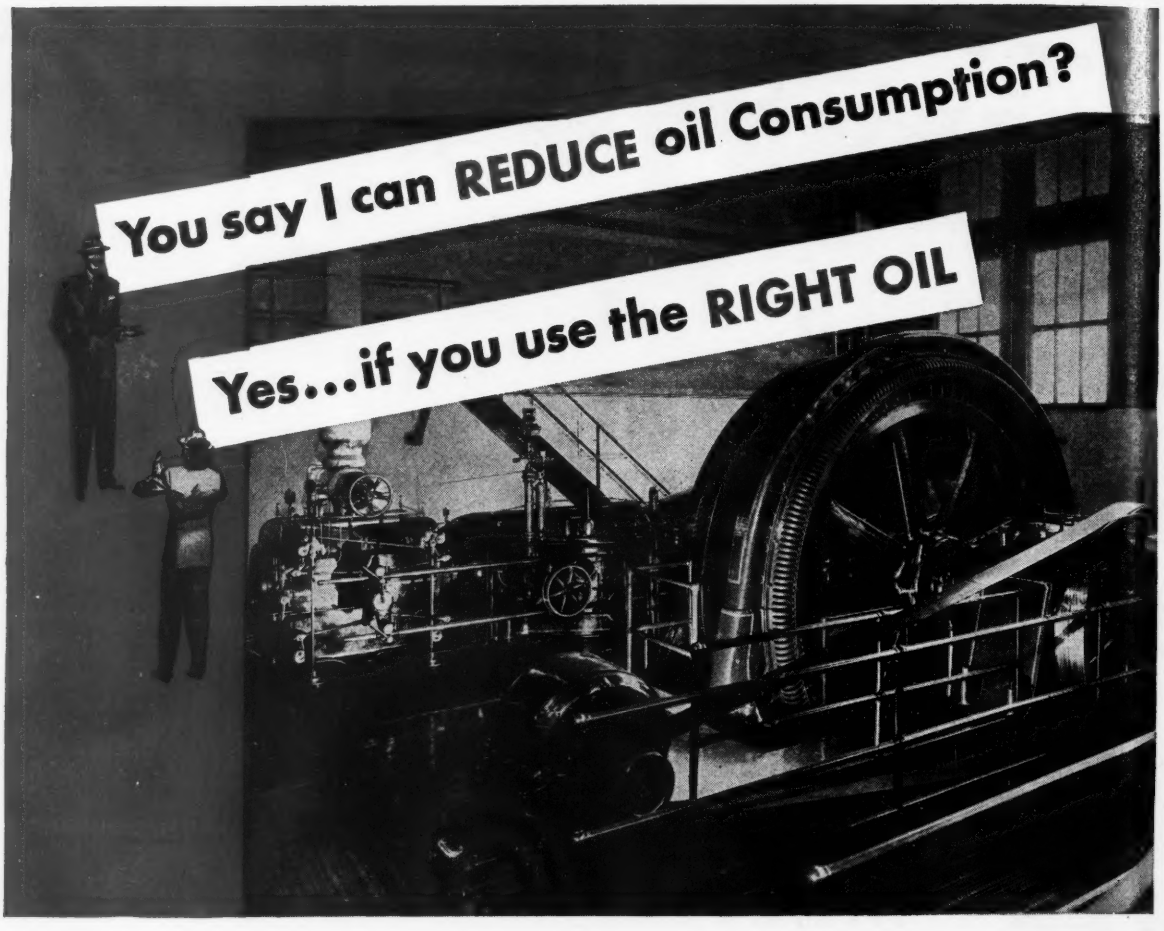

It's a case of...
TEAMWORK
ANOTHER OF THOSE
FINE ALL-ELLIOTT
INSTALLATIONS
ELLIOTT
COMPANY
JEANNETTE, PA., RIDGWAY, PA.,
SPRINGFIELD, O., NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

We may not tell you much about the plant, nor where it is—there's a war on. Just another case where vital wartime power needs are being supplied by a line of rugged, smooth-operating Elliott turbine-generator units, each served by its Elliott surface condenser.

In an installation like this, highest operating results can be taken for granted. It's a case of team-work. The Elliott units are actually designed together, built together, and when installed each clicks into its proper place without modification or compromise. Plants like these are a source of pride to their builders, and of gratification to their operating executives.

H-693

STEAM TURBINES • GENERATORS • MOTORS • CONDENSERS
FEEDWATER HEATERS AND DEAERATORS • STEAM JET EJECTORS
CENTRIFUGAL BLOWERS • TURBOCHARGERS FOR DIESEL ENGINES
TUBE CLEANERS • STRAINERS • DESUPERHEATERS • FILTERS



TWO QUALITIES are essential to assure effective steam cylinder lubrication with minimum oil consumption. The oil must (1) *atomize completely* and (2) *adhere to cylinder walls.* You get these benefits in all Texaco steam cylinder oils.

Selection of the right oil for your steam engine depends on the particular operating conditions of your installation.

That is why there is a complete line of Texaco steam cylinder oils—one to meet the requirements of every operating condition in every type of steam engine, new or old.

Whatever the operating conditions, there is a Texaco steam cylinder oil to give you quiet operation and effective lubrication with low oil consumption. If your steam is re-used for processing, Texaco has oils specially developed to assure rapid separation from the exhaust.

To assist you in selecting the right oil for your particular steam conditions, Texaco Lubrication Engineering Service is available through more than 2300 Texaco distributing plants in the 48 States. Get in touch with the nearest one, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Steam Cylinder Oils

FOR EVERY STEAM CONDITION

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON EVERY SUNDAY NIGHT—CBS

EDITORIAL STAFF

ARTHUR L. RICE
Editorial Director

RALPH E. TURNER
Editor

ANDREW W. KRAMER
Managing Editor

CHESTER R. EARLE
Associate Editor

RICHARD H. MORRIS
Engineering Editor
On leave with U. S. Army Air Forces

Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

KINGSLEY L. RICE, *President*
EDWIN C. PROUTY, *Vice President*
WALTER PAINTER, *Vice President*
ARTHUR L. RICE, *Treasurer*
CHARLES S. CLARKE, *Secretary*
JOHN O. AARVOLD, *Prod. Mgr.*

ADVERTISING REPRESENTATIVES

CHICAGO: Charles S. Clarke
53 W. Jackson Blvd., Chicago 4, Ill.
Harrison 0824

NEW YORK: John A. Kershaw
Graybar Bldg., New York 17, N. Y.
Caledonia 5-3779

PHILADELPHIA: H. G. Wilds
121 Waverly Road, Wyncote, Pa.
Ogontz 1066

CLEVELAND: A. H. Van Duyn
Union Commerce Bldg.
Cleveland 14, Ohio
Cherry 1377

PACIFIC COAST: Roy M. McDonald Co.
San Francisco: Roy M. McDonald, *Mgr.*
564 Market St.
San Francisco 4, Calif.
Garfield 8966

Los Angeles: Milo D. Pugh, *Mgr.*
541 S. Spring St.
Los Angeles 13, Calif.
Tucker 7981

WASHINGTON, D. C., NEWS OFFICE
Business News Service
10 Independence Ave.

Subscription Information—The monthly issues are sent prepaid by second class mail. Prices: United States and possessions one year $2.00 and two years $3.00. Canada one year $3.00 and two years $5.00. Other countries one year $4.00 and two years $7.00. Address correspondence about subscriptions to Circulation Manager, POWER PLANT ENGINEERING, 53 West Jackson Blvd., Chicago 4, Illinois. Changes of address should give both old and new address and reach us by 20th of month to be effective with following month's issue. The Annual Index is furnished as a part of the December issue.

Power Plant ENGINEERING

August 1945

VOLUME 49—NUMBER 8

Cover: View in Pepsi-Cola Bottling Co. of Chicago shows one of many vital power applications in the bottling industry. Through V-belts, this motor drives a water pump and a syrup pump supplying syrup and water to synchrometer. With five bottling units in action, this plant can fill 500,000 bottles per 8-hr day.

Front Lines 7

What Leaders Say 59

Design of Small Power Plants—*By H. C. Carroll* 60

Metal-Clad Switchgear Installation Hints 66

More Steam and 60-Cycle Power for Front Royal—*By Theodore Maynz* 70

Chicago Section ASME Holds Two-Day Session 75

Gas Turbine Operation in Sun Oil Refineries—*By Arthur E. Pew, Jr* 77

2000-kw Gas Turbine Plant for Power Generation 80

The Coal-Burning Gas Turbine for Locomotive Use—*By John I. Yellott* 83

Centrifugal Pump Control—Part VI—*By Igor J. Karassik* 85

The Practical Engineer and Electrician 89

A-C Network Calculator Installed at the Illinois Institute of Technology 114

New Equipment 126

Obituaries 144

Manufacturers' News 148

Manufacturers' Personals 152

News from the Field 154

New Engineering Books 160

Construction News 180

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

Copyright, 1945, by Technical Publishing Company.

Published monthly by the Technical Publishing Co., at 53 West Jackson Blvd., Chicago 4, Ill., U. S. A., Subscription price, $2.00 a year. Entered as second class matter September 8, 1932, at the Post Office, Chicago, Ill., under act of March 3, 1879. Vol. XLIX, No. 8.

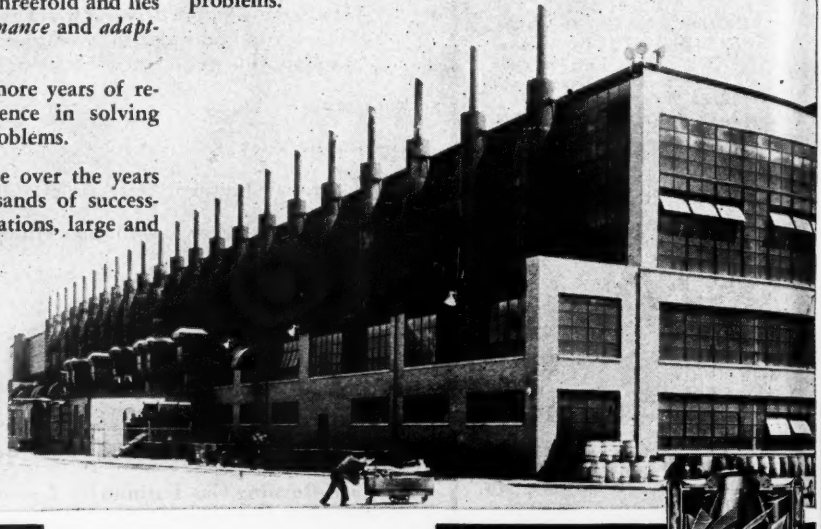
WHY DO YOU FIND MAXIMS on the really TOUGH silencing jobs?

The giant Maxims standing out against the skyline below quiet the exhaust of Diesels on test stands at a large industrial Diesel manufacturing plant. Time and again in important installations of this kind and in many smaller installations where the silencing problem is none the less critical, the most satisfactory answer has been found with Maxims.

The reason "why" is threefold and lies in *experience, performance* and *adaptability.*

- Maxim can show more years of research and experience in solving tough silencing problems.
- Maxim performance over the years is typified in thousands of successful working installations, large and small.
- Maxim adaptability means a line of silencers so varied that it is seldom necessary to go beyond the standard silencers to get a job "tailor-made" for your installation.

By the same token when special silencers *are* needed, Maxim engineers, constantly working on development and new design problems, are particularly capable of solving your special problems.



WRITE FOR BULLETINS
D 125
D 127
D 101
D 37

WRITE FOR BULLETINS
WH 100
WH 101
WH 103

These Maxim Silencers (model MUC illustrated) are designed to silence the exhaust or intake of internal combustion engines, steam engine exhaust, air compressor intake, vacuum pump discharge and the intake or discharge of blowers of the positive pressure type. Wide choice of models to fit varying space and silencing requirements. Spark arresting where necessary.

Maxim Heat Recovery Silencers combine efficient silencing of engine exhaust with spark arresting (where necessary) and with the efficient recovery of waste exhaust heat to produce steam or hot water for heating or processing operations. These Heat Recovery Silencers give highly efficient heat transfer . . . are available with automatic controls, and may be run wet or dry without injury to the unit.

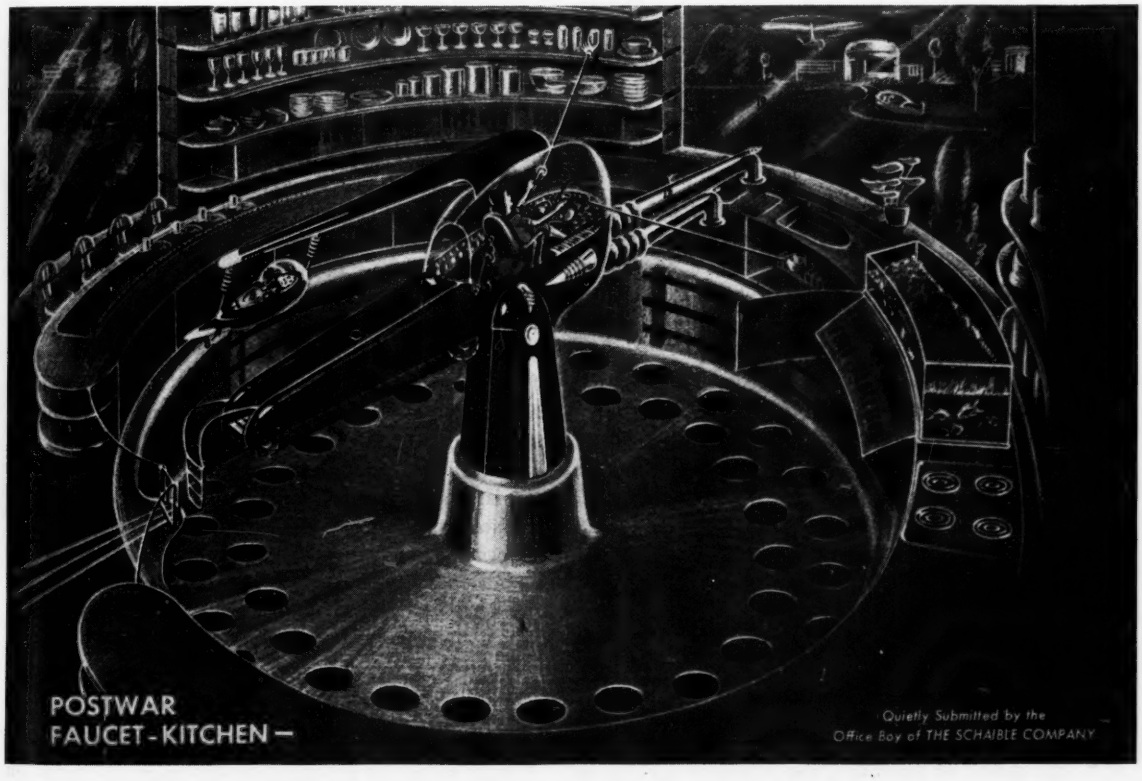
THE MAXIM SILENCER CO. • **89 HOMESTEAD AVE., HARTFORD, CONN.**

ARMY E NAVY

MAXIM

Front Lines

EUREKA! Here it is! All work eliminated (finally) in the latest Kitchen of Tomorrow!—whenever that is. We've told you in Front Lines all about the wonders of the houses of tomorow and the bathrooms of tomorow and the kitchens of tomorow and the cars of tomorow and the —But here is the greatest scoop of all. Now you can relax about future kitchens. Here is something realistic, something down-to-earth and practical. It will make today's housewife tomorow's kitchenwife. Her life will literally revolve around this kitchen. How will it work? Why —how can you ask—RADAR, of course, with a dash of miscellaneous electronics. (If it ain't got electronics in it, how could anybody sell it?) But let The Schaible Company, Cincinnati 4, Ohio, send you their gorgeous 16-color illustrated brochure describing this marvelous kitchen in detail. Here in drab black and white, we can give you only a hint of its wonders. Write Schaible "Attention Tomorrow Department." The "Yesterday Department" has been fired—or confined in appropriate institutions. Just remember this: Faucets and strainers, formerly small items, now become the basic features of the Kitchen of Tomorrow. Why? Because The Schaible Company *makes* faucets and strainers, of course! Study the photograph and see how your wife will have bottled sunrays for air conditioning; can turn the kitchen floor into a swimming pool for the kiddies at button's touch; has her moods controlled *by radar;* washes and dries the baby automatically; grows a year's supply of pre-dehydrated food in one corner of the contrap—er, device; eliminates cabbage odors or too persistent salesmen with a turret-operated pest control gun. Confidential tip to prospective purchasers: Early post-war models will NOT make MEAT.



A FEW FEATURES: Everything automatic, run by electronic controls (No. 1) in operator's booth. Everything in easy reach of Giant Whirling Faucet Unit (2). Floor, no longer of use, becomes Giant Cup-Strainer (3). For kitchen-swimming, drop cup-strainer floor, fill kitchen with water, snap diving board (4) in place. Escalator (5) to operator's booth. Multi-use flit gun (6) controls various pests, including persistent salesmen. Mood-control keyboard (7) creates any frame of mind desired. Self-rocking rocket cradle (8) for streamlined "baby of tomorrow" (9). Conveyor belt (10) with "meals of tomorrow" and newly-designed "plates of tomorrow" on way from shelf to places at uncomfortable "seats of tomorrow." Place (11) for a few kitchen antiques saved for sentimental reasons. Mechanical "reachers" (12), for performing one or two little kitchen details not quite perfected yet for automatic operation by electronics. 105 millimeter twin-spouts (13) made of glass. Streamlined sinks (14) put in just to help room look a little like a kitchen. Sinks completely useless otherwise. Packaged powdered dust (15) that turns into pre-dehydrated food. Shows "seeds" for a year's supply of food. "Flowers of tomorrow" (16) show influence of streamlining. Chemical garden (17) "raises" pre-dehydrated fruits, vegetables and fish. Hopper just below it sifts food from chemicals, fast-freezes it, and makes it into capsule meals. Electronic stove burners (18) for old-fashioned people wanting occasional hot meal. Windows (19) with one-way vision for privacy. Neighbor's house built around kitchen like this (20). And so forth, etc., etc., etc. Grim, isn't it?

MANY WAR PRODUCTS are being improved in laboratories through the science of "micrurgy." This new technique is the use of tiny tools so small that they are used only under powerful microscopes. The tools include hammers, tweezers, saws, magnets, and a chisel 10 by 30 microns in size. A mechanical device called a micro-manipulator is used to move the tools.—Ohmite News.

ABOUT 6000 American scientists have contributed their skill to the winning of this war under a co-ordinated program of the Office of Scientific Research and Development. The director of that office, Dr. Vannevar Bush, points out in the July issue of The Atlantic that the time is coming when they will turn to peaceful endeavors. What single project could they work on as important in peace as the one they have worked on in war? Dr. Bush presents a conception for such a project: an attempt to unify and make available to thinking men the vast body of technical and scientific information now in existence, which is getting to be so unwieldy that it is very difficult to use. A possible way of doing this, he thinks, is by development of many of the photographic and counting and calculating and selecting techniques we have already started to use. After reading Dr. Bush's conception of the "memex," in which is stored on microfilm all the information you would ever need and in which you would find data by association of ideas instead of by crude title indexing, you'll say, "Boy! That's what I've always wanted. How soon can I get one?"

THE WONDERS of 100 octane gasoline have been on everybody's lips during the past few years but many of the details of how it is produced have been military secrets, and very few people have a really accurate conception of the production process. In the May issue of Compressed Air Magazine, C. H. Vivian gives a very detailed description of this process with flow diagrams of the Houdry, the T.C.C. and other processes for making 100-octane gasoline. A two-page flow diagram in color shows how the fluid Catalytic-Cracking Process operates.

A GREAT DEAL of the town of Zurich is heated by means of heat pumps. This is the more remarkable, said Oscar Faber in his recent presidential address before the Institution of Heating and Ventilating Engineers in London, considering the fact that the river from which the heat is taken is generally frozen over at the time when the heat is required most.

NOW THAT THE LIGHTS are on again, following the defeat of Germany, the Statue of Liberty in New York Harbor is resplendent under a new flood light system, installed by Westinghouse. The Statue, under an illumination equivalent to 2500 times full moonlight, holds aloft a torch flame rekindled to more closely simulate actual fire. The new lighting also accentuates the expression of the face and many of the other details. The lighting system includes a new combination of mercury vapor and incandescent floodlights, designed to duplicate daytime seeing conditions.

WATCHING the recent news reel photographs of various invasions, you have doubtless noticed how jeeps and other automotive equipment splash off the ramps of landing barges into water up to the radiator caps and then busily paddle to shore. How are they able to do this without stalling the motors? The answer is a liquid chemical, hitherto secret, with which their ignition systems have been water-proofed. This chemical, known as PiB, was developed about five years ago by United States Industrial Chemicals, Inc., went into large scale production during the war and was recently demonstrated in New York before it was placed on the market for public consumption.

A LOW-TENSION, high-frequency ignition system for aircraft engines which facilitates starting in sub-zero weather, reduces aircraft engine maintenance time, minimizes effect of oil, carbon, and lead fouling of spark plugs and solves the problem so far as the ignition system is concerned, of raising the ceiling of extremely high altitude flying, has been announced by AC Spark Plug division of General Motors. The new system has been turned over to Army Air Forces technicians at Wright Field where it has operated perfectly

HAVE YOU EVER EATEN a mangosteen, an orange-like fruit with leathery skin, ivory white segments and melting flesh, which tastes something like a plum? Or a cherimoya, outwardly like a green pineapple, with snow-white juicy pulp and bean-like brown seeds? Or a granadilla, which contains very small seeds in an aromatic soft pulp? If you haven't, you may do so in the relatively near future because these are three of a great many tropical fruits and vegetables that we may be able to fly directly from the tropics to this country by airplane. The plane, says Arthur D. Little's Industrial Bulletin, is imminently suited for this work since it is smooth riding, fast, capable of long hops and travels through cool air which can be used for chilling or freezing articles in transit. One of the principal drawbacks to the scheme is that commercial cultivation of these fruits and vegetables in the tropics is not on a large scale and then there is the problem of educating American taste to them. However, the idea itself is already in operation. In one of the local newspapers this spring the advertisement of one of our best markets stated that strawberries picked that morning in the Ozarks would be on sale four hours later in the store in Chicago, having been delivered by airplane almost directly from the strawberry beds.

THE MICRO-FLASH, a high-speed, high-intensity light source for photography was originally described in the General Radio Experimenter, 1941. At that time it was designed for use on urgent defense projects and was not available for general sale. Since that time, however, a number of units have been built and have proved extremely valuable in research connected with the war effort. Some very interesting details of the way in which this process is used to photograph projectiles in flight at Jefferson Proving Ground are given in the April, 1945, issue of the Experimenter.

SHELL TURBO OILS

are refined from carefully selected crudes . . .

they're turbine oils from the ground up

SHELL TURBO OILS have shown little or no trace of OXIDATION after years of service in marine, industrial and public utility installations. They have prevented RUST FORMATION, and have resisted STRUCTURAL BREAKDOWN over similar periods—far surpassing the performance of the oils which they replaced.

To achieve anti-oxidation properties, rust-preventing quality, demulsibility and the stability for long service, these oils are developed exclusively for turbine lubrication from the ground up.

Starting with crudes carefully selected for the purpose, Shell refines these base stocks by a solvent extraction process to enhance the oil's inherent stability and demulsibility.

At the compounding stage, the oil is fortified with Shell-developed additives . . . special ingredients which, more than anything else, have established Shell Turbo Oil as a superior turbine oil.

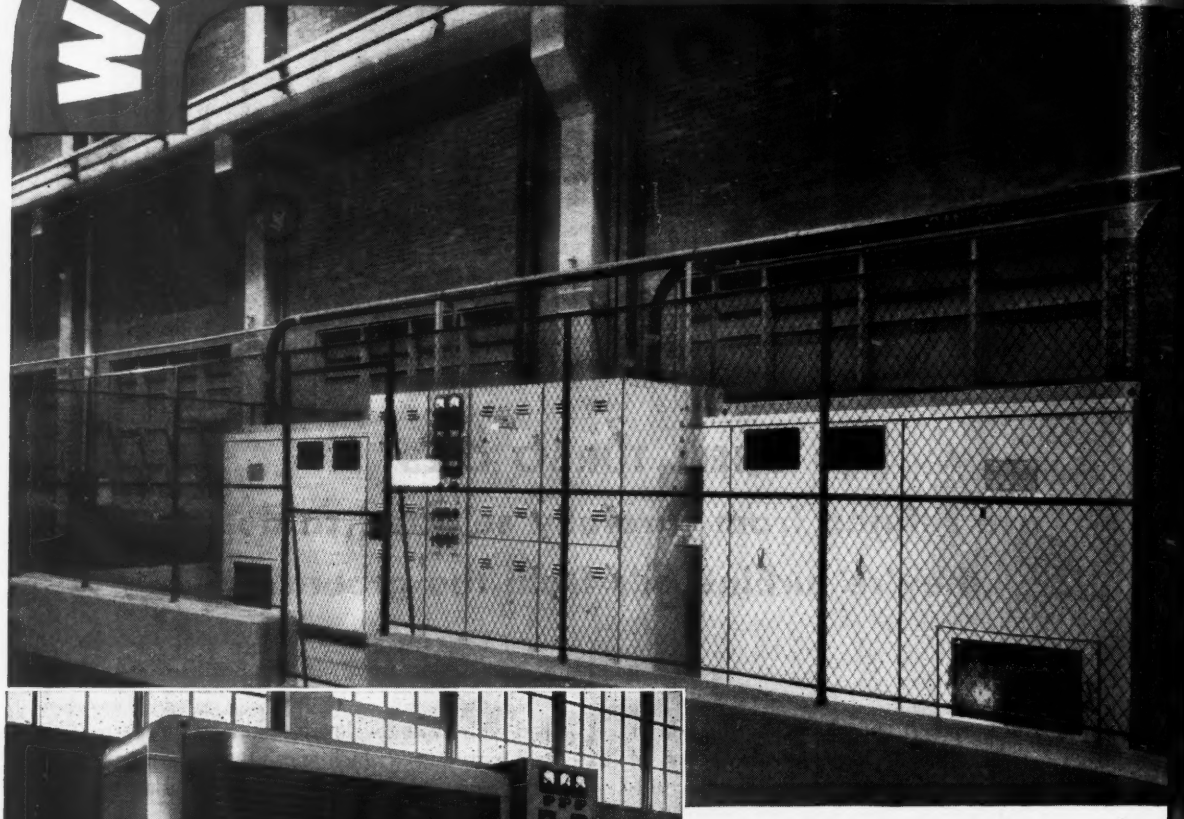
A rare anti-oxidant additive is introduced, greatly increasing the oil's naturally high oxidation resistance. Then, to give exceptional rust-preventing quality, Shell adds another compound which assures both maximum metal-covering ability and high film strength.

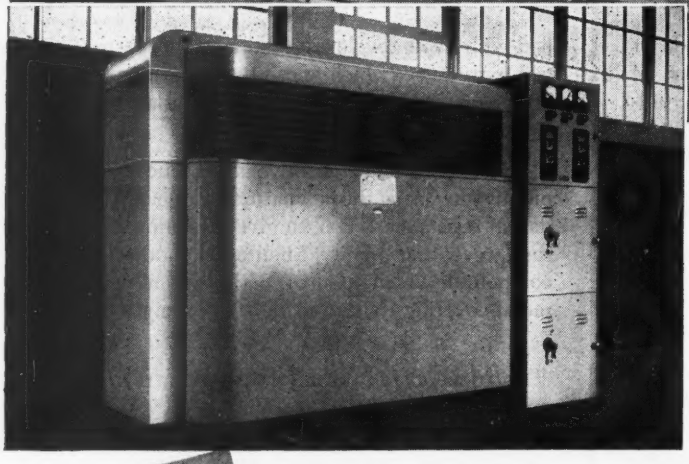
For dependable turbine lubrication, rely on Shell Turbo Oil . . . the inhibited oil with anti-oxidation and anti-rust additives. Shell Oil Company, Incorporated, 50 W. 50th St., New York 20, New York; 100 Bush St., San Francisco 6, California.

SHELL

SHELL TURBO OIL

WHY G-E dry-type transformers





At a light-metals plant in Pittsburgh—This 2000-kva, 4160- to 480-volt unit substation is one of five such installations at this plant. (The enclosing fence is to prevent tampering with controls.) Compare the metal-enclosed construction of this dry-type equipment with conventional open-screen designs.

Good looks is a standard feature of all G-E dry-type, load-center unit substations. Such units are "naturals" for distribution revamping programs because, if you so desire, you can buy them one block at a time and still end up with a completely modern co-ordinated system—a system in which the self protection of each substation confines most troubles to a small area and prevents crippling plant outages. Available in ratings from 200 to 2000 kva, 601 to 15,000 volts.

...have won wide acceptance

1. These ultramodern, dry-type distribution transformers are designed to meet AIEE Standards No. 1 for Class B insulation, with 130 C maximum hot-spot temperature in a maximum ambient of 40 C. They also meet ASA Standards C-57.1, which limit the observable temperature rise to 80 C.

2. Because they meet industry standards for hot-spot temperature, G-E dry-type transformers are better suited to handle emergency overloads than units designed to higher temperatures. Longer life under severe service conditions is the inevitable result.

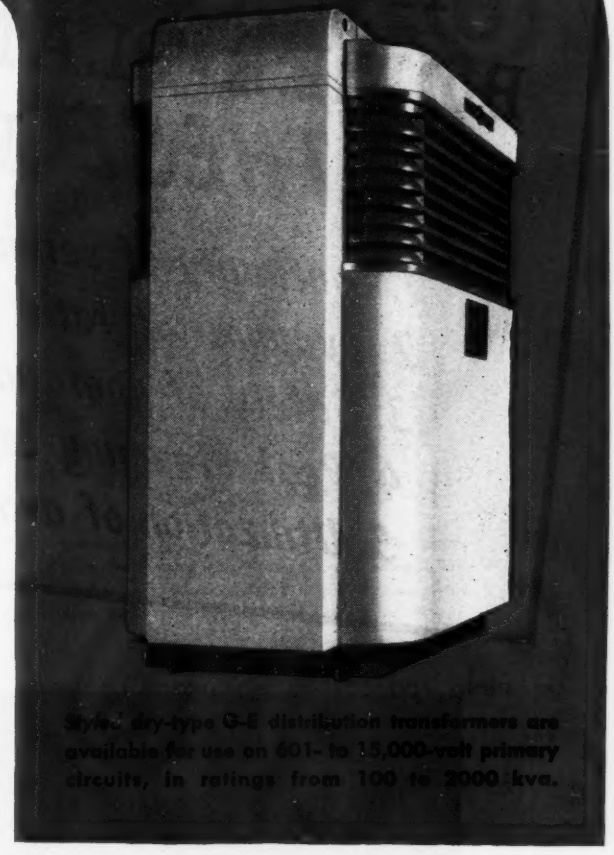
3. Housings are designed for utility, and are attractive in appearance.

4. Completely metal-enclosed construction prevents rods and wires from being accidentally pushed into the live parts.

5. There are no exposed live parts, such as bushings, that would lessen safety and make a fence mandatory.

6. Cable terminal compartments are completely removable, so the high-voltage and low-voltage cables can be made up and the unit slid into place between them without the use of a crane or elaborate hoisting and jacking facilities.

7. Transformer side plates are readily removable to facilitate inspection and cleaning of the core and coils.



Style-1 dry-type G-E distribution transformers are available for use on 601- to 15,000-volt primary circuits, in ratings from 100 to 2000 kva.

If you prefer dry-type designs, you will find these ultramodern dry-type transformers ideal for modernizing your plant's power system.

Their trim good looks, their safety, and ease of installation make dry-type units "at home" anywhere in your plant.

They fit right in with the economic good sense of *load-center power distribution*, which offers savings in installation cost, power, and assurance of full voltage at every lamp and machine.

When these transformers are a part of unit substations, the interrupting capacity of the substation switchgear section is exactly matched (electrically, mechanically, thermally) with the transformer capacity. It is adequate for even the most severe short circuits.

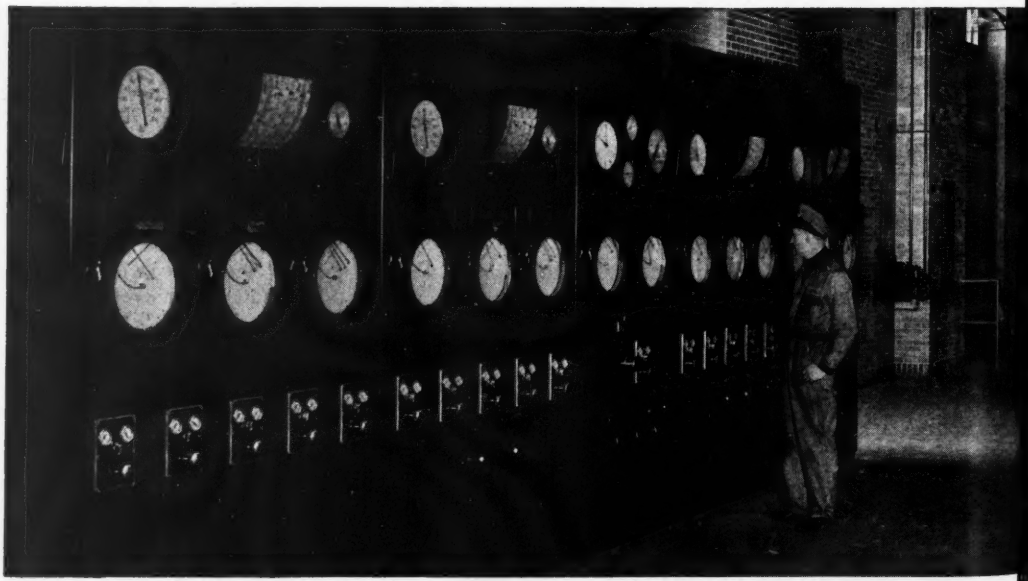
Ask for Bulletin GEA-3592A (load-center unit substations); Bulletin GEA-3714B (dry-type distribution transformers). ***General Electric Company, Schenectady 5, N. Y.***

GENERAL ELECTRIC

BUY WAR BONDS

HOW DOES YOUR BOILER PLANT RATE ON *THESE* POINTS?

1. Continuity of service.
2. Evaporation ratio.
3. Safety of operation.
4. Peak steaming capacity.
5. Utilization of available manpower.



This Bailey Boiler Control Panel continuously maintains Optimum Performance in a central heating plant.

BAILEY METER CONTROL

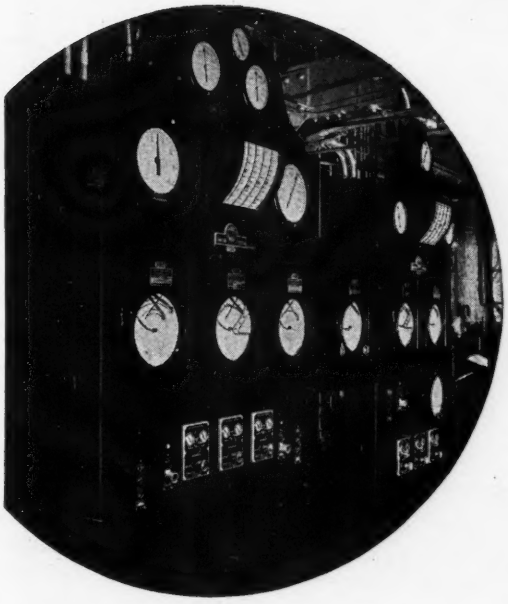
BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPER

★ Optimum performance may be secured on all these counts by applying engineered instrumentation in the form of Bailey Boiler Meters and Control.

Bailey Boiler Meters and Control are specified and applied to the individual requirements of each plant. Bailey engineering service starts with the selection of equipment and continues through the design, construction, calibration, installation, and final adjustment on the job.

Engineering work in the user's plant is done by Bailey Field Engineers, who have been thoroughly trained in combustion and automatic control practice. These engineers are stationed in over thirty industrial areas throughout the United States and Canada for the purpose of rendering prompt "on the spot" engineering service without undue traveling expense.

The Bailey Engineer in your community has a background of combustion engineering "know-how" which has been accumulated through years of service. He has at his command the results of thousands of tests on boiler installations covering a wide range of fuels, furnaces, and fuel burning equipment. He has more to offer than meters and controllers. He is primarily interested in helping you to secure optimum operating conditions in your plant. G-24



Installation of Bailey Boiler Meters and Boiler Control in an Eastern paper mill. This equipment automatically functions to maintain daily boiler performance at the same high standards obtained during boiler tests.

BAILEY METER COMPANY
1040 IVANHOE ROAD, CLEVELAND 10, OHIO
Bailey Meter Company Limited, Montreal, Canada

...he Complete Combustion Control System

...TROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

HOW TO TRAP

Standard cast semi-steel bottom-inlet, top-outlet traps for pressures to 250 psi. Also available side-inlet, side-outlet. Same interior mechanism as traps for pressures to 2400 psi.

. . . for maximum

There have been three distinct trends in power plant development since the first Armstrong trap went to work back in 1911:

1. Higher pressures.
2. "All steel" pipe and fittings.
3. Automatic condensate drainage.

Armstrong has kept pace with all three developments by building traps specially suited to the power plant engineer's needs.

Forged Steel Traps—available with screwed or flanged connections for pressures to 2400 psi. Traps you can depend on to automatically drain headers and protect equipment after a boiler outage, saving manual attention of a busy engineer. Traps that won't fail under high superheat conditions. Traps that give you a high safety factor.

Piston-operated Compound Traps — super capacity traps for header and separator drainage and rapid discharge of water from purifiers where boiler foaming or priming is a problem. Capacities to 300,000 lbs. per hr.

Engineers like Armstrong traps because they are not a nuisance. They are the highest quality traps on the market and don't require a lot of maintenance. They cost a little more than some, but well worth it because of longer life, less attention and freedom from steam leakage.

The subjects of condensate drainage, heat transfer, condensation rates, trap selection, installation and maintenance are admirably covered in the ARMSTRONG STEAM TRAP BOOK. Ask for a copy. ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Michigan.

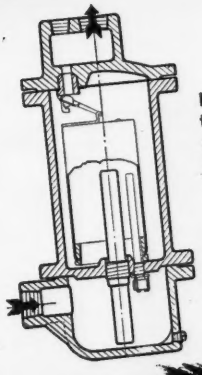
ARMSTRONG "INVERTED BUCKET" STEAM TRAP

ARMSTRONG

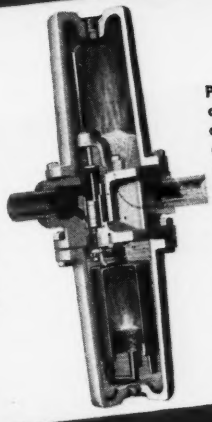
Over a Million in Use . . .

POWER PLANT

Forged steel traps for pressures to 2400 psi. Screwed or flanged connections: Chrome steel valve and seat, hardened, ground, and lapped. 18-8 stainless bucket and valve lever assembly.



Inverted bucket trap with special chamber to eliminate damaging vibration when installed in conjunction with reciprocating engines, pumps, etc.



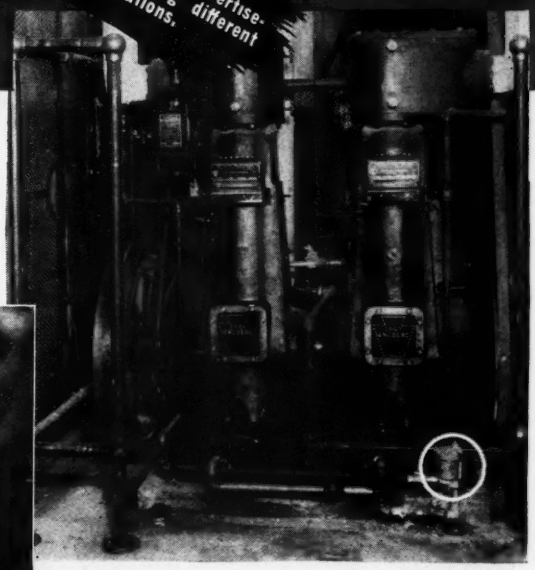
Piston operated compound trap for any steam-using equipment producing extremely large volumes of condensate. Capacities up to 300,000 lbs. per hr. Pressures to 600 psi.

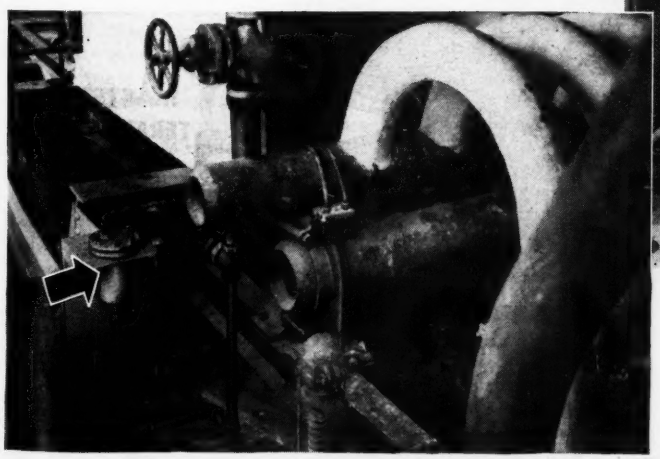
One of a series of advertisements each discussing different steam trap applications.

safety and less work

Right — No. 801 trap with angle connections draining supply line to steam engines.

Below — No. 313 forged steel trap on saturated steam header.



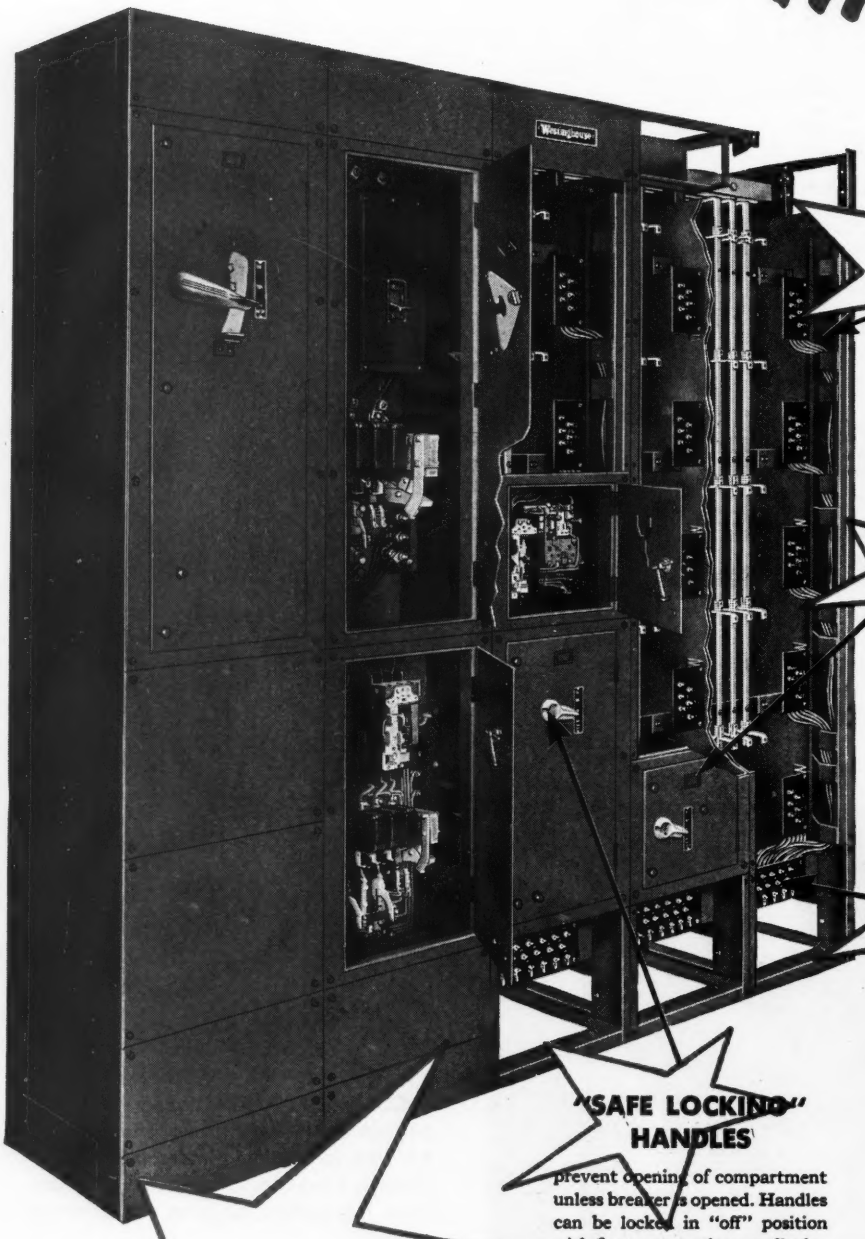


COMPRESSED AIR USERS: Ask for bulletin on the Armstrong *Snap Action* Air Trap for draining intercoolers, aftercoolers, receivers, air lines, etc. Also traps for venting air from closed water systems.

Inverted Bucket **STEAM TRAPS**

For Power . . . Process . . . Heating

Easier to install



ACCESSIBLE VERTICAL WIRING TROUGH

in each unit facilitates rearrangement of individual units and simplifies wiring, should master terminal boards not be desired.

STARTER UNITS EASILY REMOVED

from front of structure for relocation or maintenance—provides new operating flexibility.

MASTER TERMINAL BOARD

conveniently located at bottom (or top) of a control center, simplifies connection of outgoing leads. Individual terminal boards make wiring easy to identify, simple to change—connections between starters and master terminal boards made at factory.

"SAFE LOCKING" HANDLES

prevent opening of compartment unless breaker is opened. Handles can be locked in "off" position with from one to three padlocks.

FRONT OR BACK-TO-BACK MOUNTING

. . . twice the number of units can be installed without increasing depth of structure when back-to-back mounting is employed.

FOR ANY CONTROL CALL WESTINGHOUSE

WESTINGHOUSE

easier to maintain...

Application and operating flexibility of Westinghouse Control Centers saves man-hours in installation... and maintenance ... saves space with diversity of mountings.

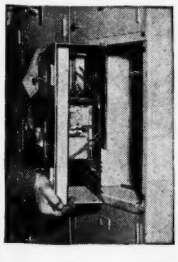
A big reason why Westinghouse Control Centers are easier to install and maintain is simplicity of design. It simplifies control center problems from planning, ordering . . . down to the last item of maintenance. Regardless of the diversity of ratings required in one structure, a Westinghouse Control Center (built from standardized units) is available. There are three basic reasons for this flexibility:

1. ***Standardized dimensions*** of the main structure and of individual units. Size 1, 2, 3 and 4 linestarters are mounted in the same sheet steel structure—only section heights vary.

2. ***Standardized terminal board system*** simplifies wiring because all internal connections are made at factory—all outgoing connections are conveniently located on master terminal board at top or bottom of starter.

3. ***Individual starter units*** or sections can be rearranged quickly. Units can be installed anywhere in the structure, in any combination.

Because of this complete standardization... of every part... Westinghouse Control Centers result in much lower over-all cost than made-to-order multimotor control panels. These are only a few advantages of standardized prefabricated Westinghouse Control Centers. All units are standard Westinghouse control items . . . offering the benefit of the half century of Westinghouse control experience. For information, write your Westinghouse office. Ask for Booklet B-3026. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. J-60599

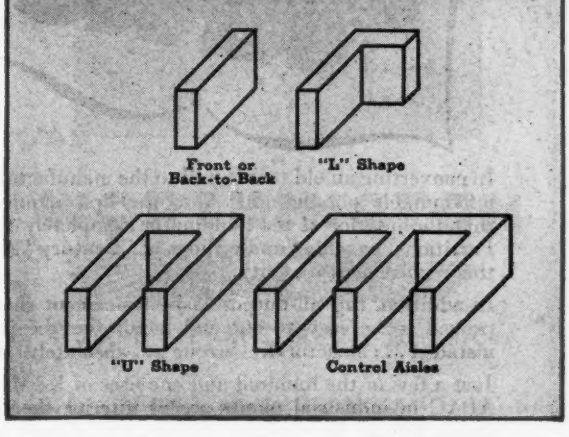


ALL INDIVIDUAL UNITS EASILY REMOVED

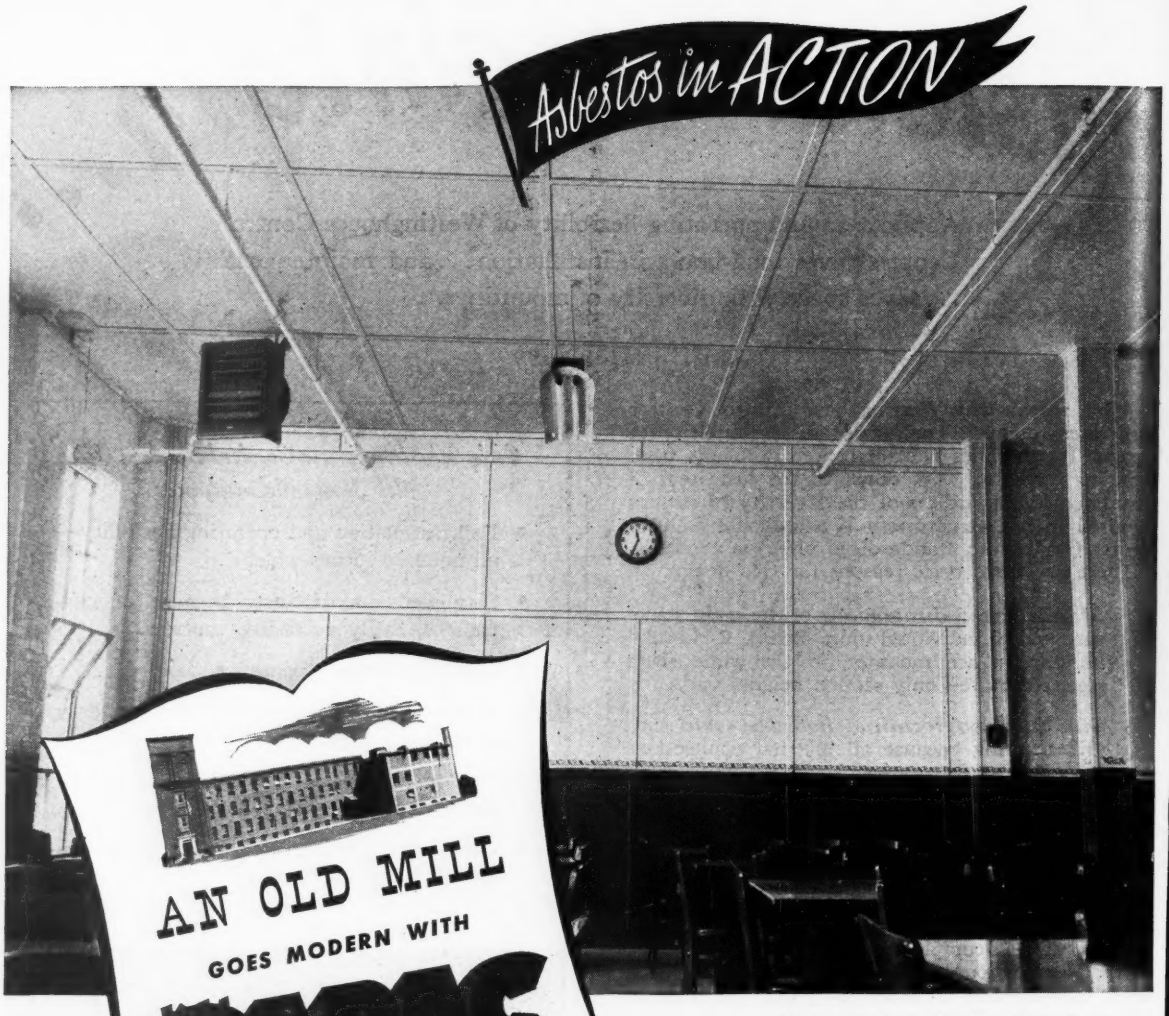
It's easy to remove an individual unit —a self-contained combination linestarter (circuit breaker and magnetic across-the-line starter)—just remove line and load leads and loosen four corner screws on trim. Entire unit then slides out for inspection or replacement. Each unit is completely baffled.

Only Westinghouse Control Centers Offer All These Advantages:

- Full installation and operating flexibility—all units 20 inches wide.
- Simplified maintenance, because of centralized, easily accessible controls.
- Smart, modern appearance.
- Standardized structures, permitting easy addition of control units.
- Full mounting flexibility. Starters can be mounted front only, or back-to-back.
- Complete operating safety assured by "safe locking" handles.



Westinghouse CONTROL CENTERS



In converting an old textile mill to the manufacture of highly inflammable photographic film, the first requirement was that the interior of the building be completely fire-proofed. Partitions, panelling and ceilings of "Century" APAC made this requirement a reality.

In addition, this all-purpose asbestos-cement sheet material proved to be easy to cut and handle on the job, quickly installed . . . structurally strong . . . absolutely dependable.

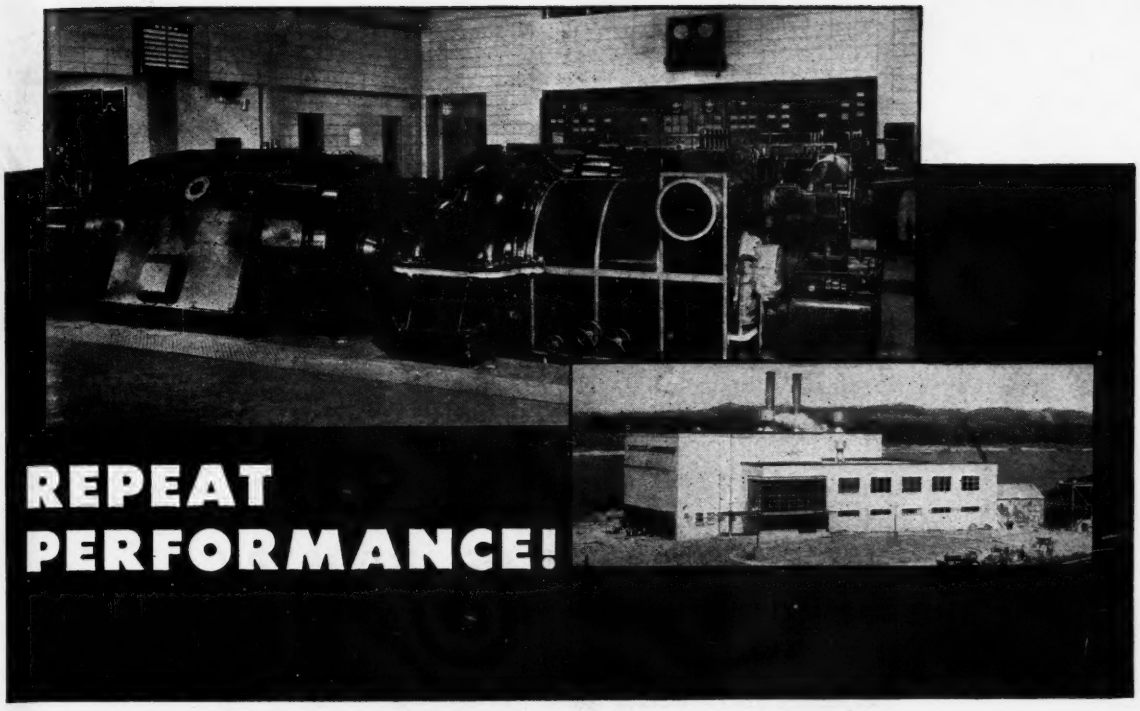
Just a few of the hundred and one uses of K&M "Century" APAC in industrial plants are as interior sheathing of all kinds, linings for elevator casings and shower stalls. It is also ideally suited for exterior roofing and siding. "Century" APAC has solved many new construction and repair problems. It is effective, economical and keeps maintenance costs amazingly low.

You'll understand why industrial engineers turn to K & M "Century" APAC when you check these advantages:

1. Made of Asbestos Fibre and Portland Cement.
2. Pleasing light gray color.
3. Fire resistant and durable.
4. Convenient size—4' x 8'. Thicknesses 3/16" 1/4" and 3/8".
5. Low cost.
6. Rat and termite proof.
7. Easy to cut, handle and apply.
8. Fastens with nails or screws.
9. Practically no maintenance required.
10. Prompt delivery.

ARMY E NAVY
K&M best in asbestos

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA



REPEAT PERFORMANCE!

For the third time since 1940, Dairyland Power Cooperative is installing an *additional* Worthington Turbine Generator in its Genoa, Wisc., Power Plant, supplying electricity to farm communities of Wisconsin, Iowa and Minnesota.

One of the outstanding power cooperatives of the country, Dairyland will have 14,000 KW of installed Worthington turbine generators, when the 4000 KW unit now being built is installed.

All units operate with 650 psi initial steam pressure . . . at 825° F. . . . and exhaust to 28.5 inches vacuum. Write for complete details. *Worthington Pump and Machinery Corporation*, Moore Steam Turbine Division, Wellsville, N. Y.

IN LEADING POWER PLANTS AROUND THE WORLD

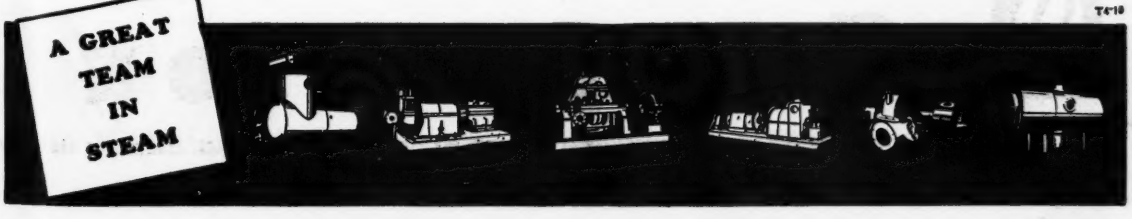
- Turbine Generator Units (up to 7500 kw.—all types)
- Multi-stage Turbines (up to 10,000 hp. —all types)
- Single Stage Turbines (up to 1500 hp.)
- Combined Turbine & Gear (5 to 200 hp.)
- Speed Reducing & Speed Increasing Gears

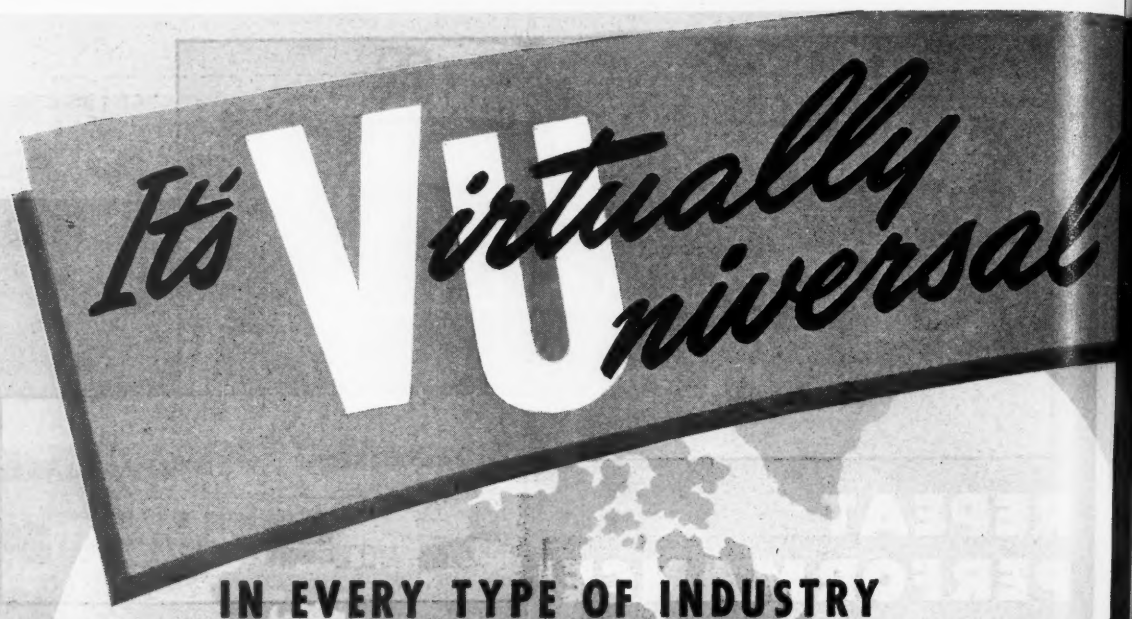
WORTHINGTON

MOORE STEAM TURBINE DIVISION

Nationwide Service — Offices and Representatives Throughout the World

T-610





IN EVERY TYPE OF INDUSTRY

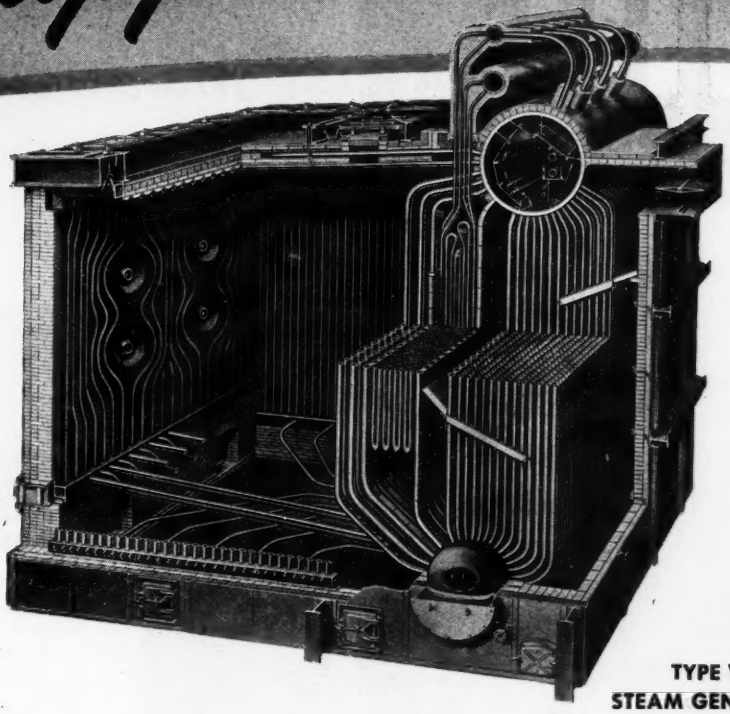
Nothing reveals the universal character of the VU Steam Generator better than a list of the industries where it is in operation bringing higher standards of efficiency to plants requiring boiler capacities from as little as 20,000 lb of steam per hr to as much as 300,000 lb per hr. Moreover, this comprehensive spread of industrial applications accompanies an equally significant geographical distribution, with VU installations not only in the United States and Canada, but also in Latin America and such remote regions as Russia, China and Arabia.

Airplane Engines	Department Stores	Paper & Paper Board
Asphalt	Distilleries	Public Utility
Automobiles	Electrical Equipment	Refrigerators
Breweries	Explosives	Railways
Building Materials	Food Products	Radio
Car Building	Linoleum	Rubber
Carpeting	Leather Goods	Steel
Cement	Locomotives	Sugar
Chemicals	Meat Packing	Textile
Coal Mining	Metal Working	Tobacco
Coke	Mining	Universities
Confectionery	Non-ferrous Metals	U. S. Navy Department
Dairy Products	Oil Refining	U. S. War Department

C-E COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR

in application



TYPE VU
STEAM GENERATOR

FOR EVERY TYPE OF FUEL AND FIRING

Another evidence of universal character is the versatility of the VU Unit with respect to fuels, a quality which means there are no geographic limitations of its application. It is supplied for burning pulverized coal, oil, gas or any combination of these fuels. It is also adaptable to firing with every basic type of stoker which means that it can be employed for any type of coal. C-E supplies the equipment for all of these methods of firing bringing the customer a coordinated installation designed for high efficiency performance . . . in the range from 80 to 88 percent.

FOR A WIDE RANGE OF CONDITIONS

The VU Unit is designed for a wide range of steam conditions. Installations range in capacity from 20,000 to 300,000 lb of steam per hr. Design Pressures are from 200 to 1000 psi and Total Steam Temperatures range up to 900F.

• • •

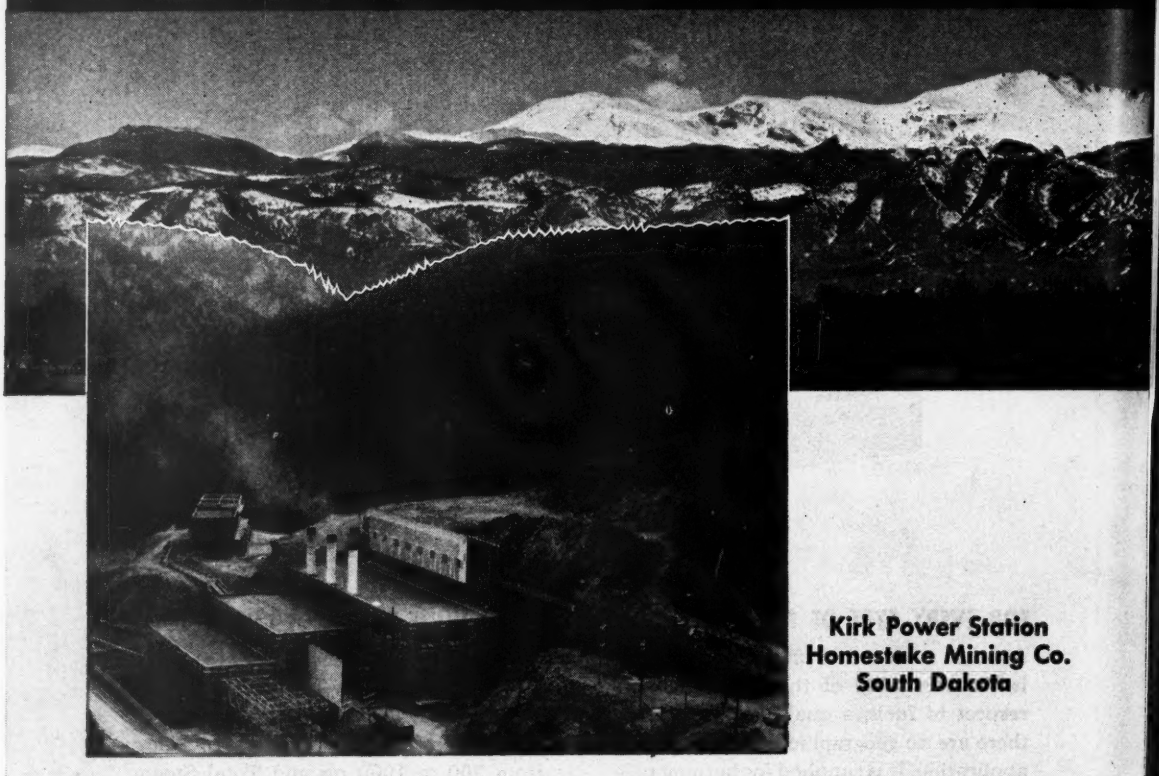
This impressive record of VU acceptance in all branches of industry is reason for your special consideration of this modern unit for your next boiler installation.

A-898

COMBUSTION ENGINEERING

200 MADISON AVENUE NEW YORK 16, N. Y.

WHY



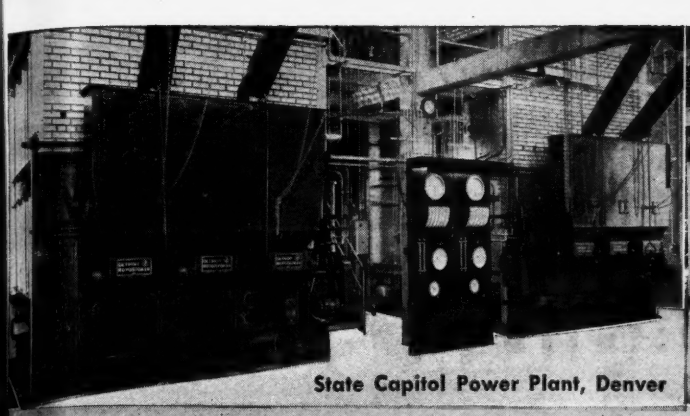
Kirk Power Station
Homestake Mining Co.
South Dakota

RotoStokers are used in the West because of their ability to burn Lignite, Sub-bituminous and Bituminous coals, mined in the Western States.

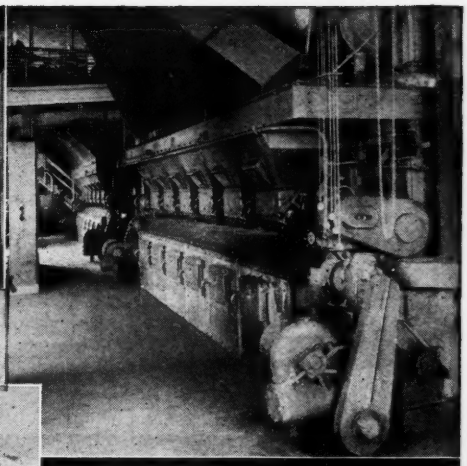
Fuels of high or low ash content without special preparation are used. High burning rates—for long periods. Even fuel beds maintained, regardless of changes in load. Reliable with both steady and variable conditions. High CO_2. Low combustible loss.

Investigate Detroit Stokers. They cut the cost of producing steam. Write for bulletin now.

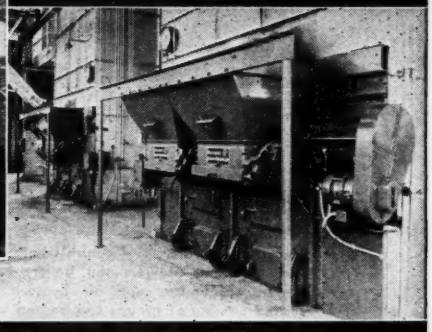
DETROIT STOKER COMPANY



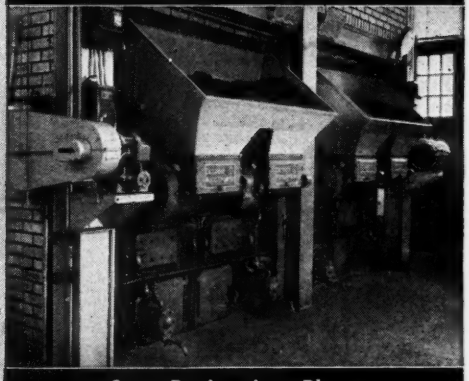
State Capitol Power Plant, Denver



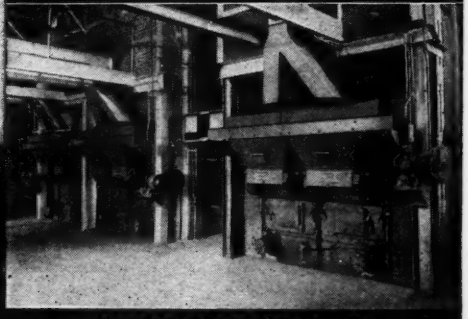
Rocky Mountain Arsenal, Denver



Municipal Plant
Fort Collins, Colorado



State Penitentiary Plant
Canon City, Colorado



American Crystal Sugar Co.
Missoula, Montana

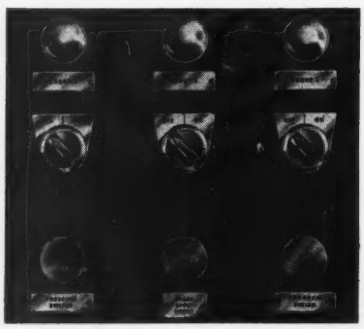
• Detroit Stoker Users in the Rocky Mountain Area

Armour & Company
Fort Morgan, Colorado
Denver Ordnance Plant
C., B & Q. Railroad
Colorado Utilities Corporation
National Sugar Mfg. Company
Denver Medical Depot
Albuquerque & Cerrillos Coal Co.
University of Colorado
Camp Carson
Vanadium Corporation of America
Colorado State Hospital
Pikeview Mine
Denver & Rio Grande Railroad
Cheyenne Steam Laundry
Alliance, Nebraska
Colorado & Southern Railway
Nuckolls Packing Company
Colorado Milling & Elevator Co.
Colorado State Home for Children
Wyodak Coal Company
Gunnison, Colorado
T. Eaton Co., Western Ltd.
Utah-Idaho Sugar Co.

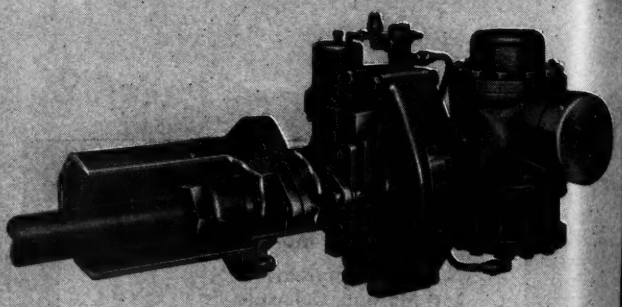
GENERAL MOTORS BUILDING
DETROIT 2, MICHIGAN
WORKS AT MONROE, MICHIGAN
Built in Canada at London, Ontario
District Offices in Principal Cities

LOWER OPERATING COSTS

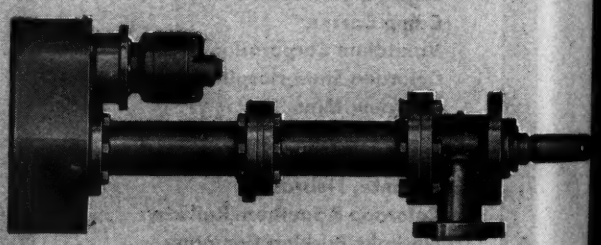
BETTER BOILER CLEANING



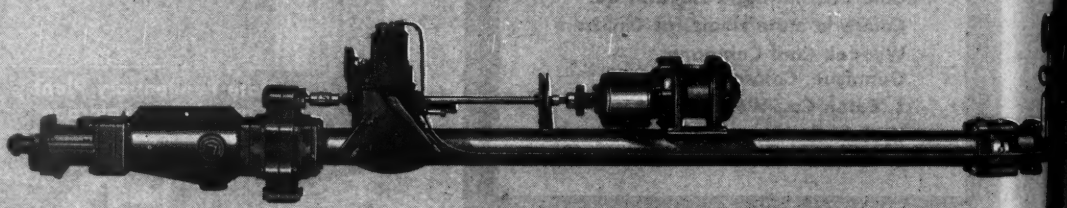
Diamond Program panel controls both fixed and retracting blowers (on boiler, superheater, economizer and air heater). Any desired number of groups can be had when system is designed, but panel shows three groups. Entire soot blowing system is operated automatically in proper sequence and at correct speed by simply pushing "start" button. Any group can be operated independently by simply throwing a switch on control panel.



Diamond "Air Puff" Soot Blower having element permanently installed inside the setting. Compressed air for cleaning is discharged from nozzles in a series of short puffs with substantial pauses between which permits use of a much smaller compressor. Air operation automatically rotates element to new position during each puff. Designed with large valve and large air passages to minimize pressure drop.



Diamond Model IF Retracting Soot Blower (at right) uses compressed air as the cleaning medium and is electrically operated.



Diamond "Telescopic" Soot Blower uses compressed air (or steam) as the cleaning medium and is electrically operated as shown; air operation also available.

DIAMOND POWER

RESULT FROM

DIAMOND

AUTOMATIC SEQUENTIAL

SOOT BLOWING with AIR

Soot and slag removal with compressed air instead of steam has a number of important advantages that make for lower operating costs as well as better boiler cleaning. Air eliminates the expense of boiler feed-water makeup, and saves energy from the coal pile. Air provides a dryer medium which is particularly desirable for surfaces operating near the dew point. Air is a more effective medium for slag removal because of its greater density and lower temperature. Air requires less blower maintenance on the basis of experience on installations in service since 1940. Air requires no piping insulation. Air permits better control of fly ash flow and grain loading of gas to dust collectors or to atmosphere. Air, when introduced intermittently instead of continuously, eliminates upset operating conditions during soot blowing period.

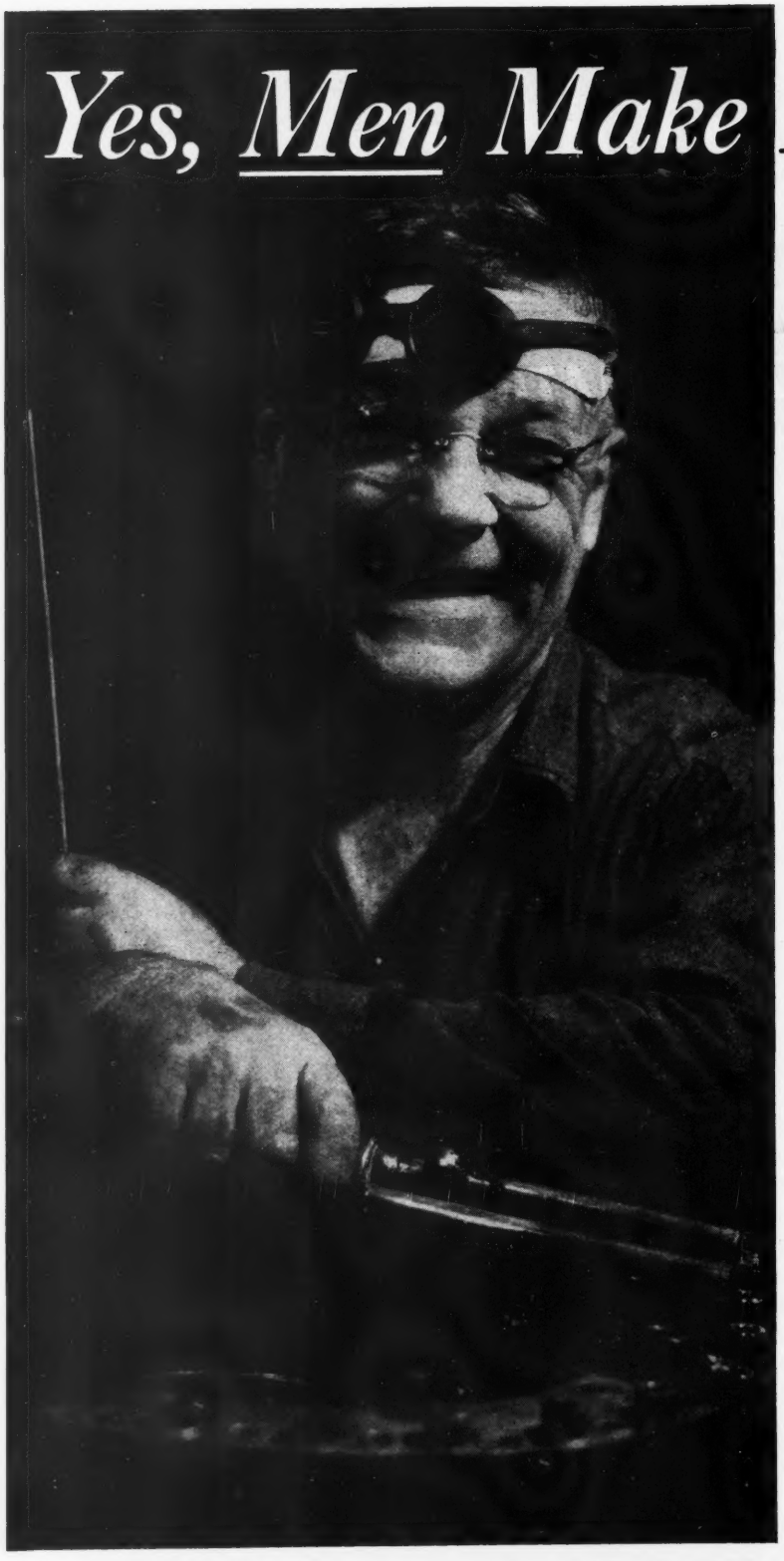
Other important advantages that are common to all Diamond Automatic Sequential Soot Blower Systems (steam as well as air) are a saving in labor and the elimination of the "human element" which assures that all blowers are operated in proper sequence and at correct blowing speed every time they are operated. Blowers can be either electrically or air operated and controlled —or a combination of both. System can be remotely operated from boiler control board or most convenient location.

Write for further information regarding Diamond Automatic Sequential Air Soot Blowing Systems that have been giving very satisfactory service on boilers as large as 900,000 lb/hr since 1940.

SPECIALTY CORP. Detroit 31, Mich.

DIAMOND SPECIALTY LTD. • Windsor, Ontario

Yes, Men Make Motors!



NO MACHINE KNOWN can duplicate the skill of Sam Meister, left, of Allis-Chalmers Norwood Works.

Holding an acetylene torch in his right hand, a silver alloy rod in his left, Sam silver-brazes end connections of Allis-Chalmers' "Indestructible Rotor."

Round and round the connections he works — expertly flowing in molten alloy to form a joined structure that can withstand as much heat as though it were a single die-casting.

No machine can do that job — and no machine can fully test how well it is done.

There's only one test . . . wait 5, 10, 15 years and *see.*

And that's the test in which Allis-Chalmers motors have proved over the years that they're *great* motors. That's why you hear it said so often: *"You can depend on Allis-Chalmers Motors!"*

• • •

YES, HUNDREDS of Allis-Chalmers men—craftsmen like Sam Meister — know they have a big personal stake in every Allis-Chalmers motor. When they build a great motor for you, they're making a *friend* . . . and they know that's something no company and its workers can have too many of.

Next time *you* need great motors contact our district office. Or write direct to ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

A 1730

AC WE WORK FOR VICTORY WE FIGHT FOR PEACE

YOU CAN DEPEND ON ALLIS-CHALMERS MOTORS

ORIGINAL LITHOGRAPH
by BENTON SPRUANCE

Insulate ... to cut production costs

Heat escapes—silently and unseen—from unprotected piping and equipment wherever ambient temperature is lower than that of the equipment itself. And these heat losses, even over a short period of time, add up to surprising amounts. They are a hidden tax on your cost of doing business.

Every avenue of escape, from boiler, steam line, fitting and heated surface, can be blocked by the application of an efficient thermal insulation, such as Ehret's 85% Magnesia or Enduro. These time-tested insulating materials are easy to apply, not readily damaged by shock or seepage, and maintain their high efficiency throughout their service life. For upwards of fifty years they have been known and widely used throughout industry.

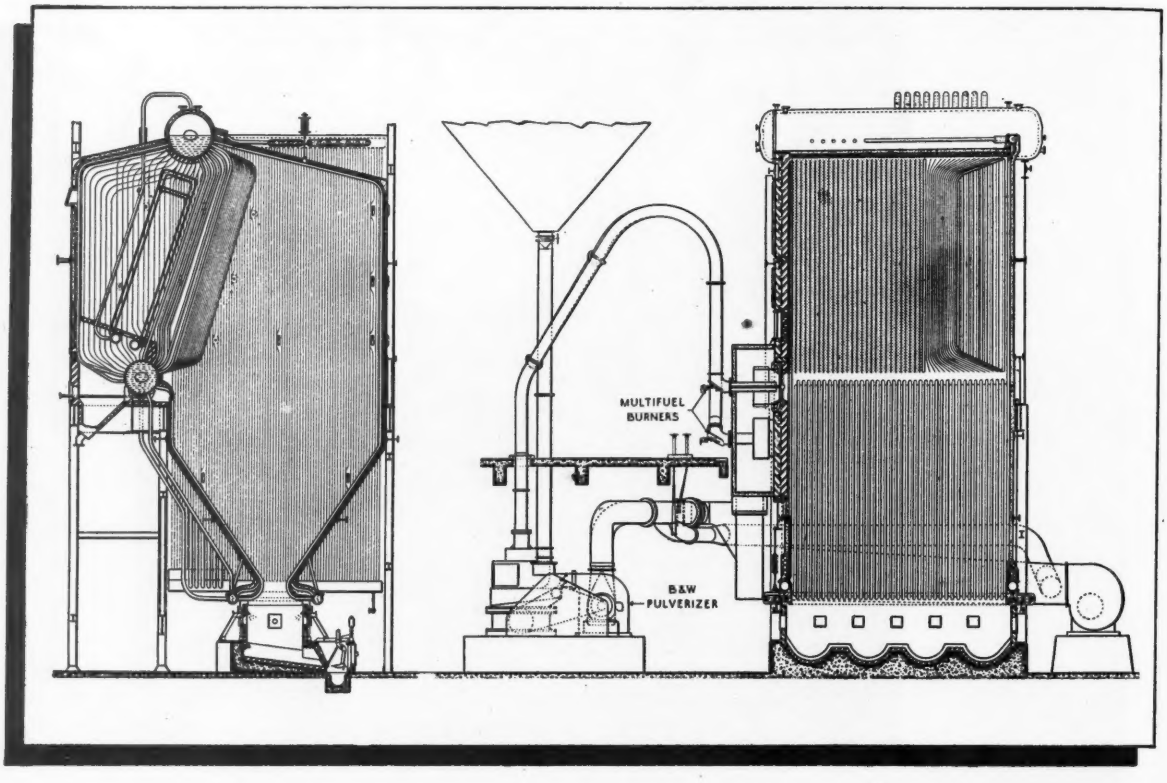
THE EHRET HEAT INSULATION HANDBOOK *contains a wealth of information on 85% Magnesia, Enduro high temperature and many other insulations—with selection and application data for boilers, piping and equipment. Fully illustrated, it includes heat loss and efficiency tables, specifications and recommendations for every temperature condition. A copy will be sent at your request.*

EHRET

MAGNESIA MANUFACTURING CO.

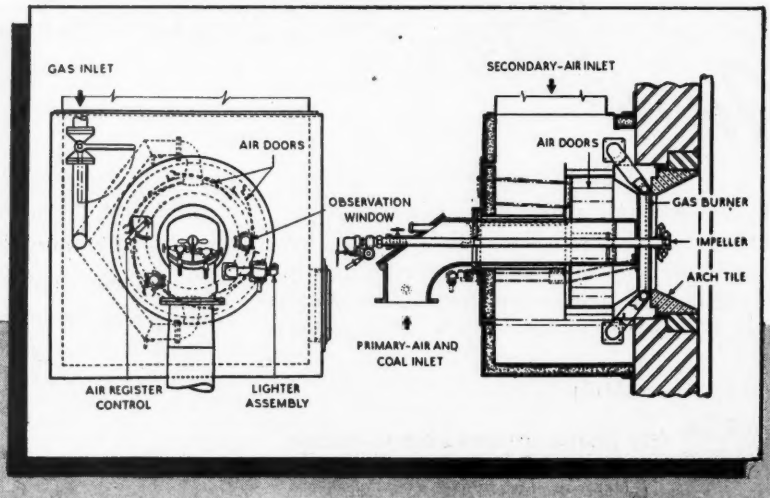
VALLEY FORGE • PENNSYLVANIA

Use All Three



Above—Typical B&W Integral-Furnace Boiler arranged for Multi-Fuel Firing.

Right—Details of B&W Multi-Fuel Burner.



with ONE Burner

Whether there is a COAL shortage or an OIL shortage there's no need for converting and then re-converting . . . or installing *separate* burners for coal, oil, and gaseous fuels when any fuel becomes scarce. Variations in fuel availability can always be met when your boilers are equipped with the

B&W MULTI-FUEL CIRCULAR BURNER
for Pulverized Coal, Oil, and Gas

This burner provides in ONE compact unit the features of the B&W Combination Oil and Gas Burner and those of the B&W Circular Burner that is so widely used for pulverized fuels. This combination, properly co-ordinated with furnace and boiler design, provides a wide latitude in choice of fuels:—all grades of coal and petroleum coke in pulverized form, oil, and gas. These may be burned singly or in any desired combination. High combustion efficiency with *any* fuel is assured through turbulent mixing of fuel and air. Let Babcock & Wilcox engineers explain how this equipment can simplify your fuel-burning problems.

Send for Bulletin G-20 A describing this B&W Multi-Fuel Burner and the B&W Combination Oil & Gas Burner.

B&W

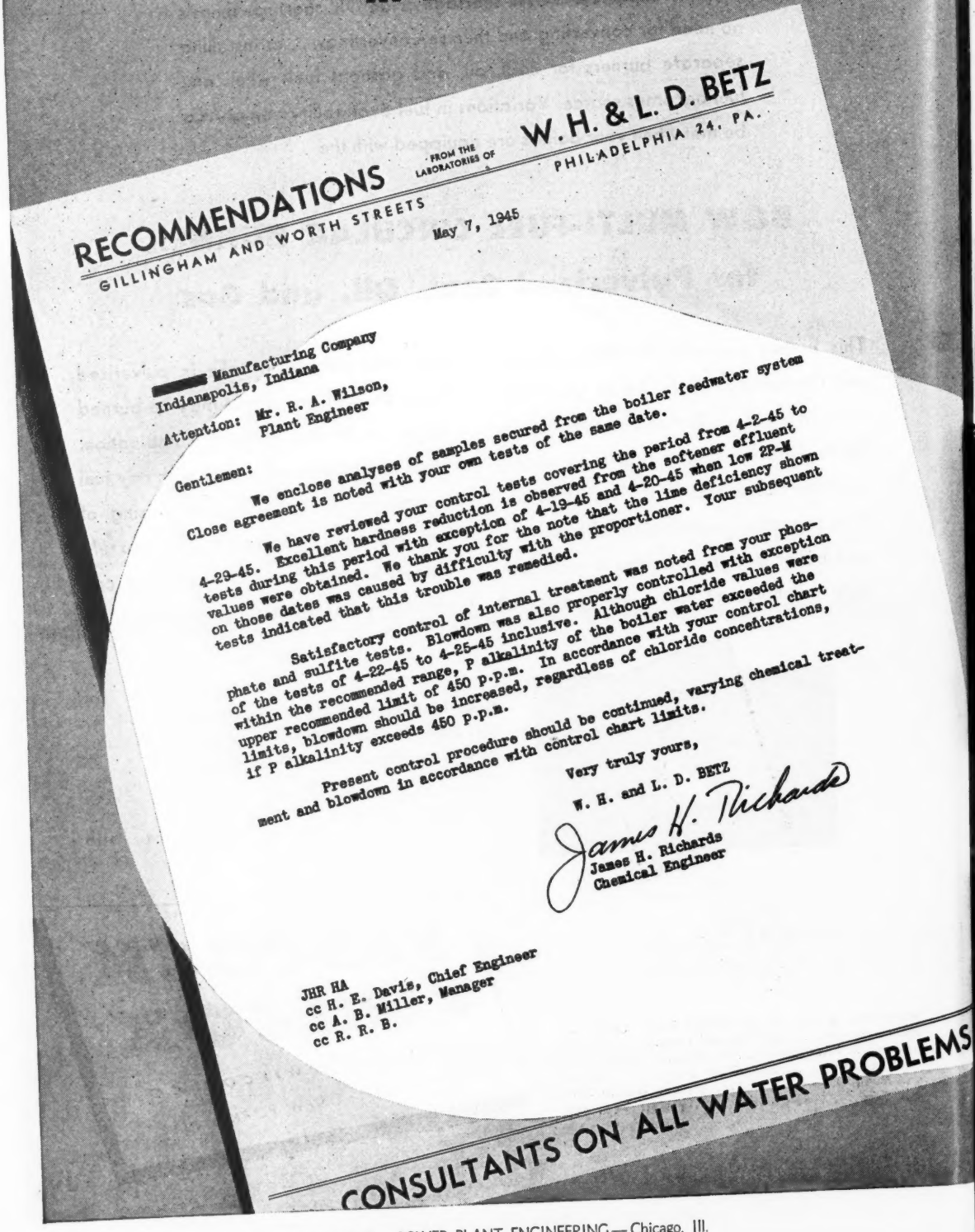
Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 LIBERTY STREET · NEW YORK 6, N. Y.

G 2817

Why Betz Stresses *Engineering Guidance* in Boiler Water Control . . .



RECOMMENDATIONS
GILLINGHAM AND WORTH STREETS
FROM THE LABORATORIES OF
W. H. & L. D. BETZ
PHILADELPHIA 24, PA.

May 7, 1945

[redacted] Manufacturing Company
Indianapolis, Indiana

Attention: Mr. R. A. Wilson,
Plant Engineer

Gentlemen:

We enclose analyses of samples secured from the boiler feedwater system
Close agreement is noted with your own tests of the same date.

We have reviewed your control tests covering the period from 4-2-45 to
4-29-45. Excellent hardness reduction is observed from the softener effluent
tests during this period with exception of 4-19-45 and 4-20-45 when low 2P-M
values were obtained. We thank you for the note that the lime deficiency shown
on those dates was caused by difficulty with the proportioner. Your subsequent
tests indicated that this trouble was remedied.

Satisfactory control of internal treatment was noted from your phos-
phate and sulfite tests. Blowdown was also properly controlled with exception
of the tests of 4-22-45 to 4-25-45 inclusive. Although chloride values were
within the recommended range, P alkalinity of the boiler water exceeded the
upper recommended limit of 450 p.p.m. In accordance with your control chart
limits, blowdown should be increased, regardless of chloride concentrations,
if P alkalinity exceeds 450 p.p.m.

Present control procedure should be continued, varying chemical treat-
ment and blowdown in accordance with control chart limits.

Very truly yours,

W. H. and L. D. BETZ

James H. Richards

James H. Richards
Chemical Engineer

JHR HA
cc H. E. Davis, Chief Engineer
cc A. B. Miller, Manager
cc R. R. B.

CONSULTANTS ON ALL WATER PROBLEMS

The most important step in the boiler water control service furnished by W. H. & L. D. BETZ is the regular monthly report prepared by our Engineering Department and which is termed "Recommendations". This report is submitted directly to the plant.

A typical report is shown on the facing page. It should be noted that these "Recommendations" offer constructive criticism and advice where applicable and suggest changes in the control when necessary. In this manner the plant obtains the benefit of professional engineering supervision which is so essential for proper chemical treatment and control. This is a continuous close supervision which is coupled with the plant's own control applied thru a daily testing program which has also been established by our Engineering Department. Thus, as copies of the plant's daily test records are received by our Engineering Department, they are immediately reviewed by our Chemical Engineers and if any divergence from the established control is detected, the plant is notified at once. Otherwise, if the record appears to be in good order—that is, if the daily test records indicate the chemical balances have been properly maintained—this fact is confirmed to the plant in the regular monthly "Recommendations" report in the manner shown on the opposite page.

This comprehensive engineering guidance is the keystone of Betz Service. That is why we stress it to all of our clients. It is their assurance against unscheduled boiler outages which can so often result in costly production delays. A service such as this is a "must" in modern boiler plant operation.

W. H. & L. D. BETZ

Gillingham & Worth Sts., Philadelphia 24, Pennsylvania

THE 6 FUNDAMENTALS OF BETZ BOILER WATER CONDITIONING SERVICE

1. Complete plant investigation and report.
2. Establishment of plant control.
3. Daily plant control tests.
4. **Detailed review of plant tests and report.**
5. Supplementary complete laboratory analyses.
6. Periodic "check-up" visits.

No. 4 in a series of advertisements outlining the fundamentals of Betz service.

CHEMICAL ENGINEERS—
CONSULTANTS ON ALL WATER PROBLEMS

BETZ

CENTRAL ILLINOIS

FOSTER

ELECTRIC AND GAS CO.

ROCKFORD GENERATING STATION

● Two large steam generators for spreader type stoker firing are being built by Foster Wheeler to meet the particular conditions pertaining to this station.

The requirements are:
215,000 lb. per hr. (peak load)
650 lb. per. sq. in. pressure
830 deg. F. final steam temperature
85% (approximate) efficiency
Fuel—Illinois coal

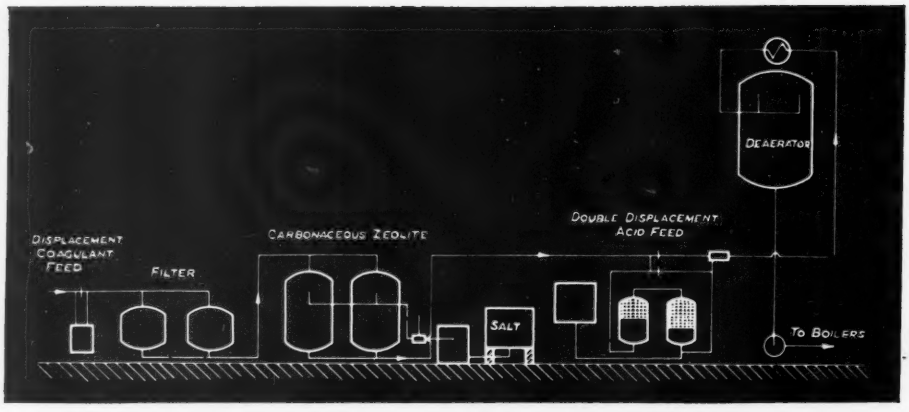
These units are of the 3-drum type with Full Water Cooled Furnaces, Convection Superheaters, Condenser type Superheat Control, Extended Surface Economizers and Two-pass Tubular Air Preheaters, as shown on the opposite page.

Selection of this design was made after thorough study by the operators and their consulting engineers of the economic and engineering problems involved.

The choice was also influenced by the exceptional performance of similar installations operating with a comparable grade of fuel.

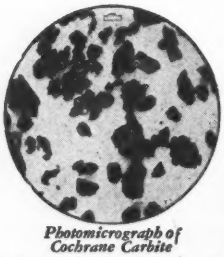
FOSTER WHEELER CORPORATION
165 BROADWAY ● NEW YORK 6, N. Y.

WHEELER FW



BAYOU WATER CONDITIONED BY COCHRANE CARBONACEOUS ZEOLITE SOFTENER

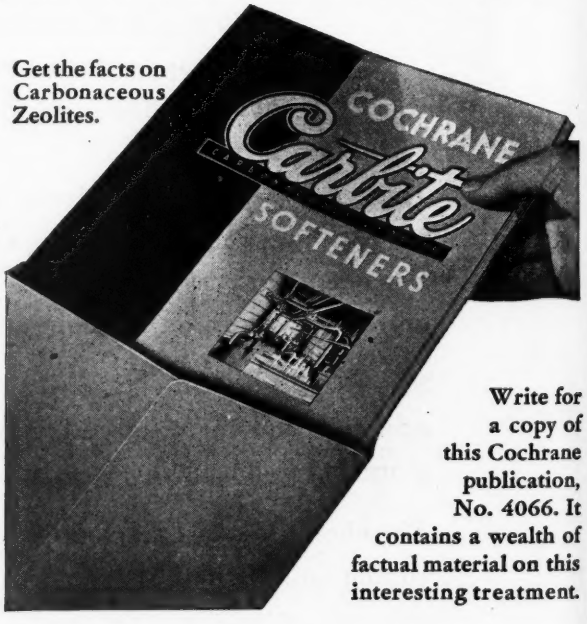
Southern plant makes use of new type of zeolite for softening feedwater after clarification and filtering by means of other Cochrane apparatus



Photomicrograph of Cochrane Carbite

THE only water available for boiler use at a newly-erected plant in the South is from a neighboring bayou. This water is highly colored, but contains little suspended matter. It is clarified with aluminum sulphate, using a Cochrane displacement type Chemical Feeder, after which it is filtered through Cochrane Filters. It is then softened in 4 Cochrane Carbonaceous Zeolite Softeners and the alkalinity reduced by the use of sulphuric acid, proportioned by a Cochrane double displacement acid-feeding equipment. It is next deaerated in a 400,000 lb./hr. Cochrane Deaerator and delivered to the boiler after receiving a supplementary phosphate treatment.

Get the facts on Carbonaceous Zeolites.



Write for a copy of this Cochrane publication, No. 4066. It contains a wealth of factual material on this interesting treatment.

COCHRANE CORPORATION
A DIVISION OF AMERICAN ENGINEERING COMPANY

ARMY E NAVY

3123 N. 17th ST., PHILADELPHIA 32, PA.

COCHRANE

SOFTENERS · DEAERATING SOFTENERS · DEAERATORS · METERS · STEAM SPECIALTIES

Clean ports pistons and crankcase . . .

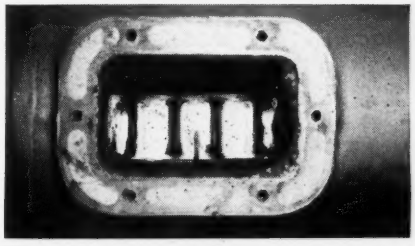
show why there was half the wear in one year's operation with

Nonpareil HD Diesel Oil

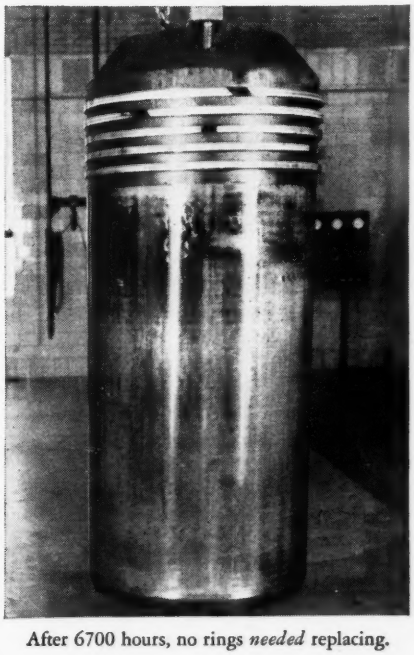
After a new 10-cylinder, Model 33-E-16 F-M Diesel operated 6700 hours during its first year in one of the largest Diesel plants in Illinois, cylinder measurements showed that there was less than half the wear usually expected in such initial wear-in and running of a new engine. The accompanying pictures show the condition of the engine at the time of inspection.

Rings are free, and there is no varnish on the pistons. Exhaust ports are almost unbelievably free from carbon or deposits. The interior surface of the crankcase looks like new.

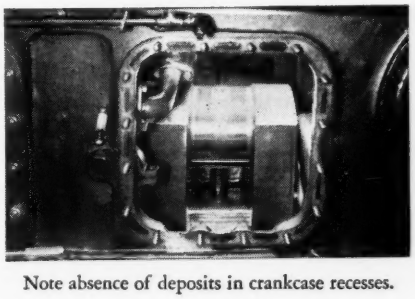
This complete freedom from troublesome deposits—the result of unusual oxidation stability *plus* detergency in Nonpareil HD Diesel Oil—means less wear, maintenance, and down time on *any type* of industrial, marine, or railroad Diesel. Put it to the test on one of your engines. A Standard Oil Lubrication Engineer will be glad to help you. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the Engineer nearest you.



When this picture was taken, ports had not been cleaned for about 1000 hours of operation.



After 6700 hours, no rings *needed* replacing.



Note absence of deposits in crankcase recesses.

Buy more War Bonds

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

★ LUBRICATION ENGINEERING

To help you avoid deposits in compressors

CONDITIONS under which compressors operate, particularly under today's heavy loads, tend to cause excessive deposits.

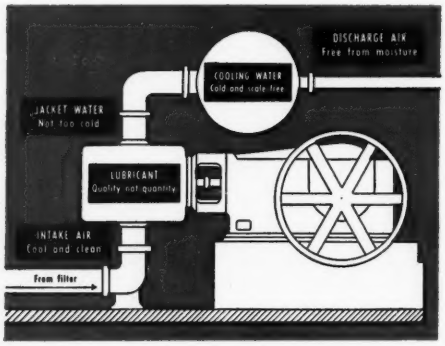
Improper lubrication is not always responsible for these deposits, but a compressor lubricant with the right qualities can reduce or eliminate many of them. Stanoil is such a lubricant.

The causes of some of the more common compressor operating problems and suggested cures, as well as the advantages of Stanoil, are listed on this page.

A Standard Oil Lubrication Engineer will be glad to help you apply the right grade of Stanoil to overcome excessive deposits and wear on your compressors. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the Engineer nearest you.

STANOIL

Buy more War Bonds



Causes and Cures

Valve Deposits—Oxygen in the air and heat generated by compression tend to oxidize conventional oils, causing the formation of carbon and asphaltic substances which deposit on valves.

To avoid oil oxidation, keep intake air temperatures as low as possible. Be sure inter-coolers and after-coolers are supplied with an ample supply of cool water, and keep them free from scale and rust. Use Stanoil, from which the unstable hydrocarbons—those affected by heat and oxygen—have been removed, thus eliminating many troublesome deposits at the source.

Dirty Intake Air. The enormous volume of air required by compressors may introduce a large quantity of dirt and dust which contributes both to excessive wear and deposits. Use efficient air screens and keep them clean. Be sure they are not located near a source of dirty air. Use Stanoil which resists the formation of gummy deposits that might collect dirt and dust and add to deposits on valves.

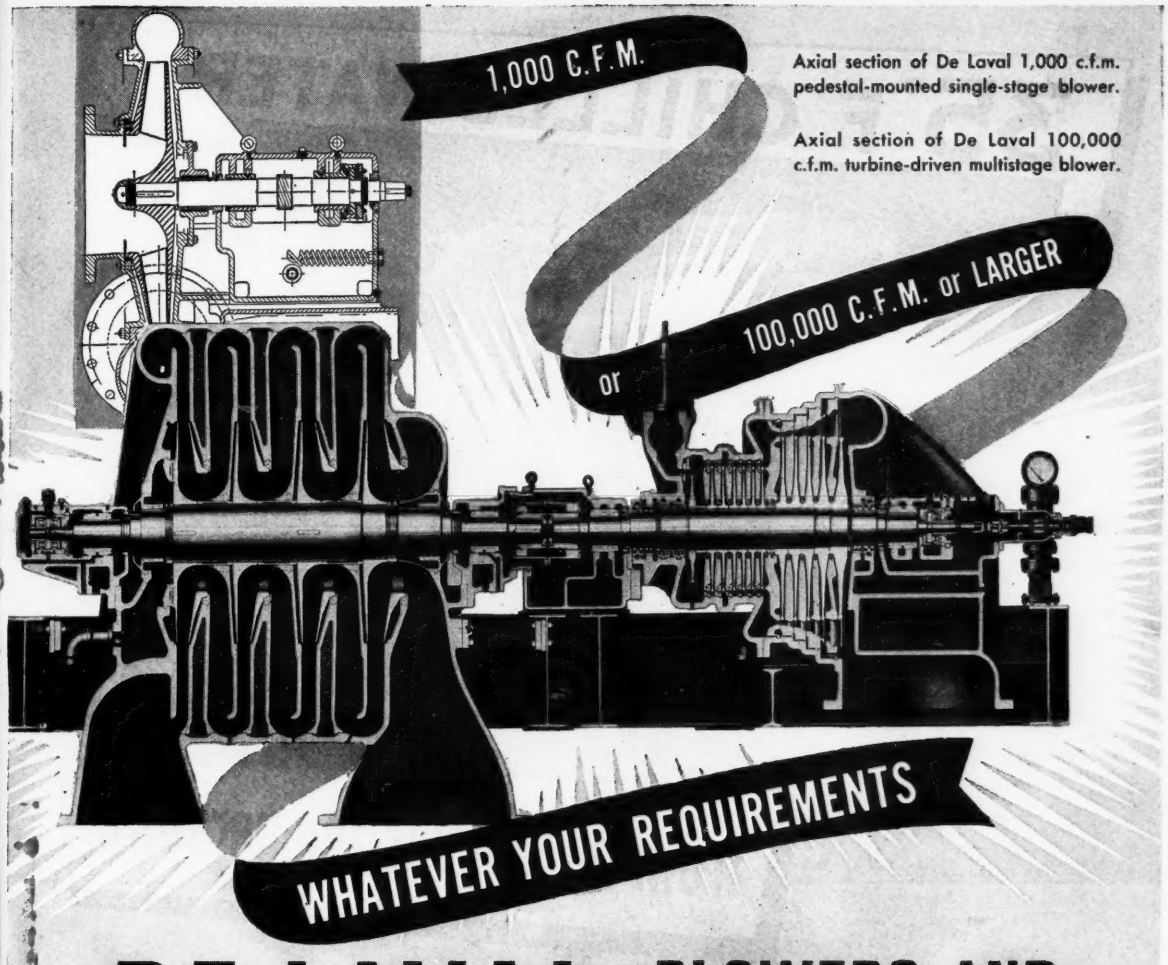
Condensation in Inter-Coolers. Water in the inter-cooler should be cold enough to condense oil and moisture in the compressed air so that they can be removed before entering the high pressure cylinders where they might cause excessive deposits.

Over-Lubrication. Oil is not burned up in compressors as it is in internal combustion engines, nor is it washed away as it is in steam engines. Oil remains in the compressor cylinder, and if it is of the right quality, very little is needed. An excessive amount of oil increases the possibility of deposits in valves, inter-coolers and air lines. Compressors usually require from 1/5 to 1/10 as much oil as steam cylinders of similar size. Because of the high lubricating quality of Stanoil, only a very small amount is needed to secure adequate lubrication.

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

★ LUBRICATION ENGINEERING



Axial section of De Laval 1,000 c.f.m. pedestal-mounted single-stage blower.

Axial section of De Laval 100,000 c.f.m. turbine-driven multistage blower.

DE LAVAL BLOWERS AND COMPRESSORS

will do the job!

De Laval blowers and compressors are available in all sizes for capacities up to 100,000 c.f.m. and above, and for pressures of from a fraction of a pound to 100 pounds per square inch and above.

For operations requiring the use of centrifugal blowers, compressors or exhausters, our engineering specialists are at your service for consultation.

3829

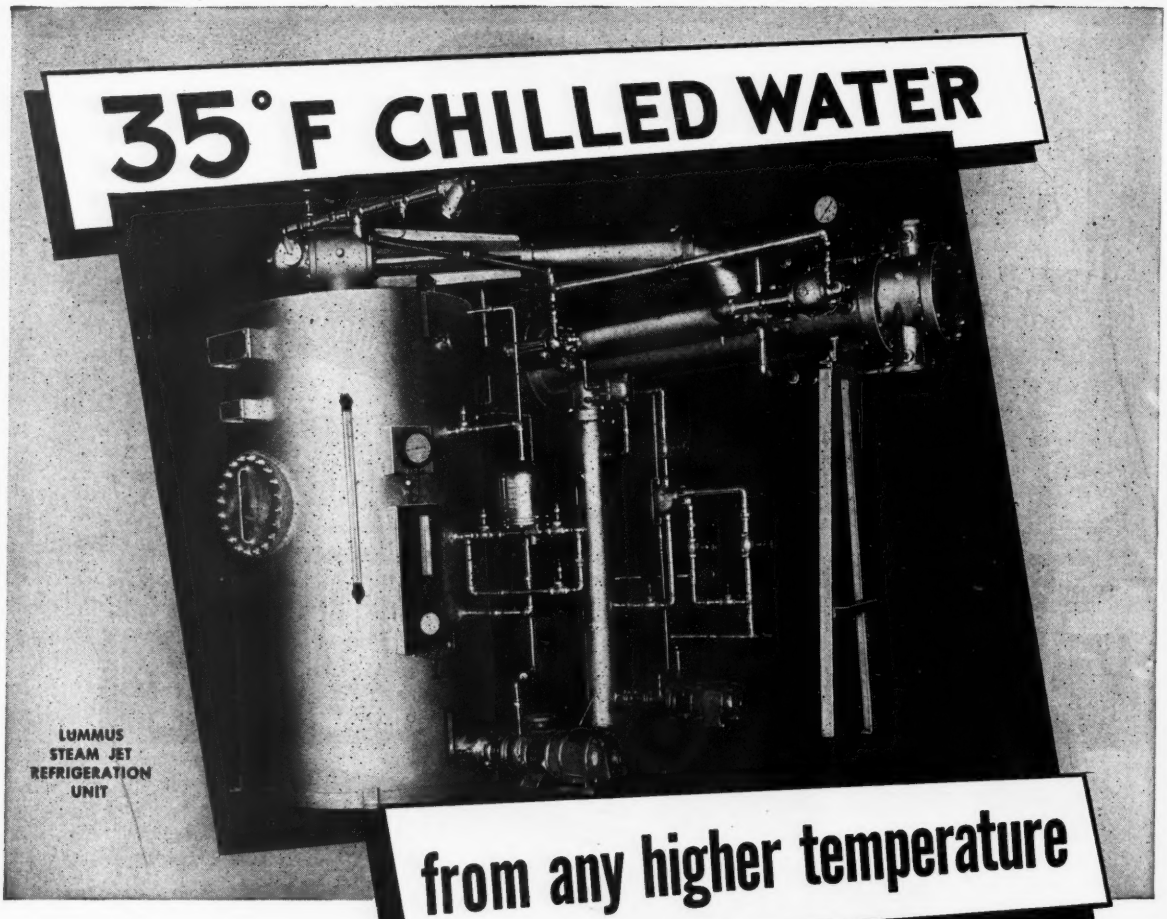
TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

35° F CHILLED WATER



LUMMUS STEAM JET REFRIGERATION UNIT

from any higher temperature

LUMMUS EQUIPMENT

HEAT EXCHANGERS
•
PROCESS CONDENSERS
•
REBOILERS
•
STEAM GENERATORS
•
STEAM JET REFRIGERATION
•
STEAM SURFACE CONDENSERS
•
BAROMETRIC CONDENSERS
•
STEAM JET AIR EJECTORS
•
EVAPORATORS
•
BOILER BLOWDOWN HEAT EXCHANGERS
•
FUEL OIL HEATERS
•
LUBRICATING OIL COOLERS
•
PIPE LINE COOLERS
•
FEED WATER HEATERS
•
JACKET WATER COOLERS

Lummus experience . . . in designing and fabricating steam jet refrigeration units for any range of operating temperatures . . . provides economical refrigeration through the use of minimum quantities of steam and condensing water.

Cooling water is chilled by the vaporization of part of the water by means of a vacuum maintained above the water's surface. The vacuum is created by jets using either exhaust or live steam. Cooling speed can be controlled automatically or manually.

Designed for simple operation, long life, low maintenance and operating costs, Lummus chilled water units are available in fully standardized sizes to meet a wide range of operating requirements and plant conditions.

Lummus engineering service is always available for the study of specific surface or barometric condenser type steam jet refrigeration problems. For further information write to: The Lummus Company, 420 Lexington Avenue, New York 17, N. Y.

LUMMUS

STEAM JET REFRIGERATION

Part of the Picture

IN OVER 12,000 BOILER PLANTS

Because it has no seat to score, wear and clog with mud, scale and dirt, the Yarway Seatless Blow-Off Valve today is "standard" in over 12,000 plants.

Power plant operators hailed this Yarway seatless-design valve instantly when it was first introduced more than a quarter-century ago. It eliminated the source of continual trouble and expense prevalent with conventional type blow-off valves.

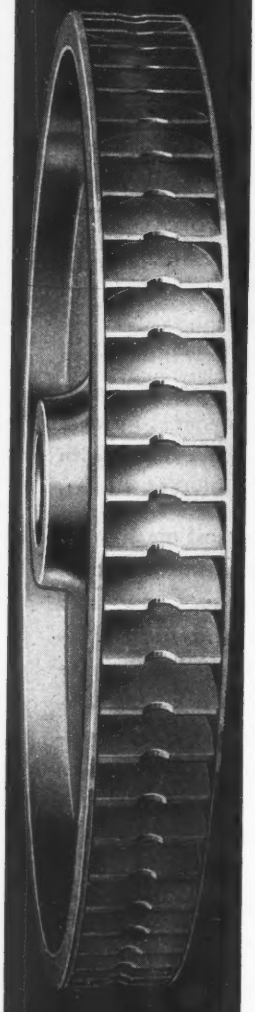
Since then constant mechanical and metallurgical research, anticipating new and more rigid service requirements, has made today's highly improved Yarway Seatless Blow-Off Valve even better insurance against boiler blow-down troubles.

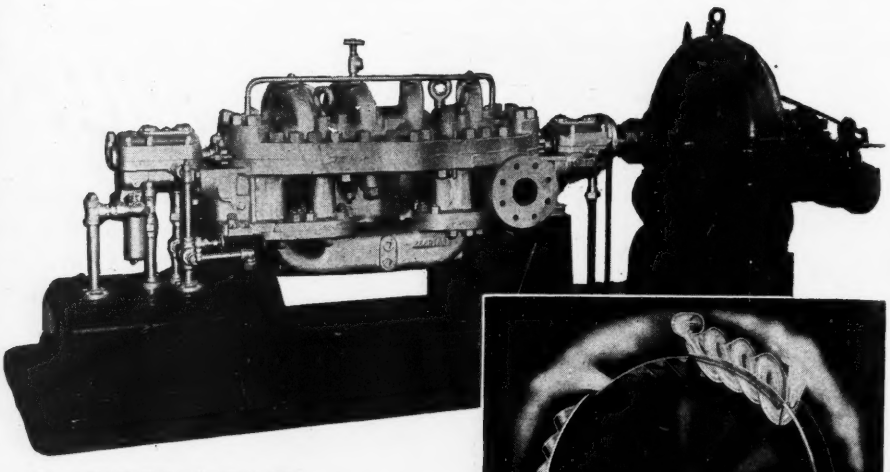
There is a Yarway Valve for every pressure. The Type "C" Seatless Tandem shown is for pressures up to 600 psi. For pressures from 400 to 2500 psi ask for Bulletin B-432; for pressures up to 400 psi ask for Bulletin B-424.

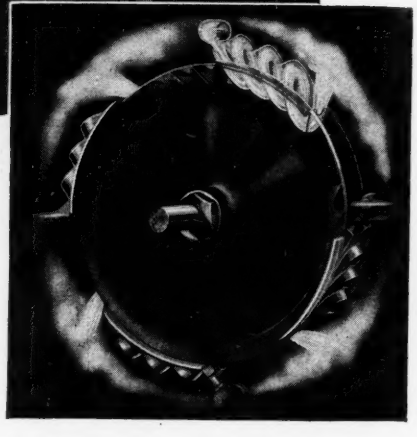
YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

YARWAY BLOW-OFF VALVES

TERRY







A DURABLE . . . EASY TO OPERATE AUXILIARY DRIVE STEAM TURBINE

Pictured above is a 125 HP Terry Solid-Wheel Turbine direct connected to a centrifugal pump. The turbine wheel of this unit is shown at the left and the action of the steam in the wheel is shown at the right.

This rotor construction offers many advantages:

— The blades and the wheel are in one piece so that there are no parts to become loose or work out.

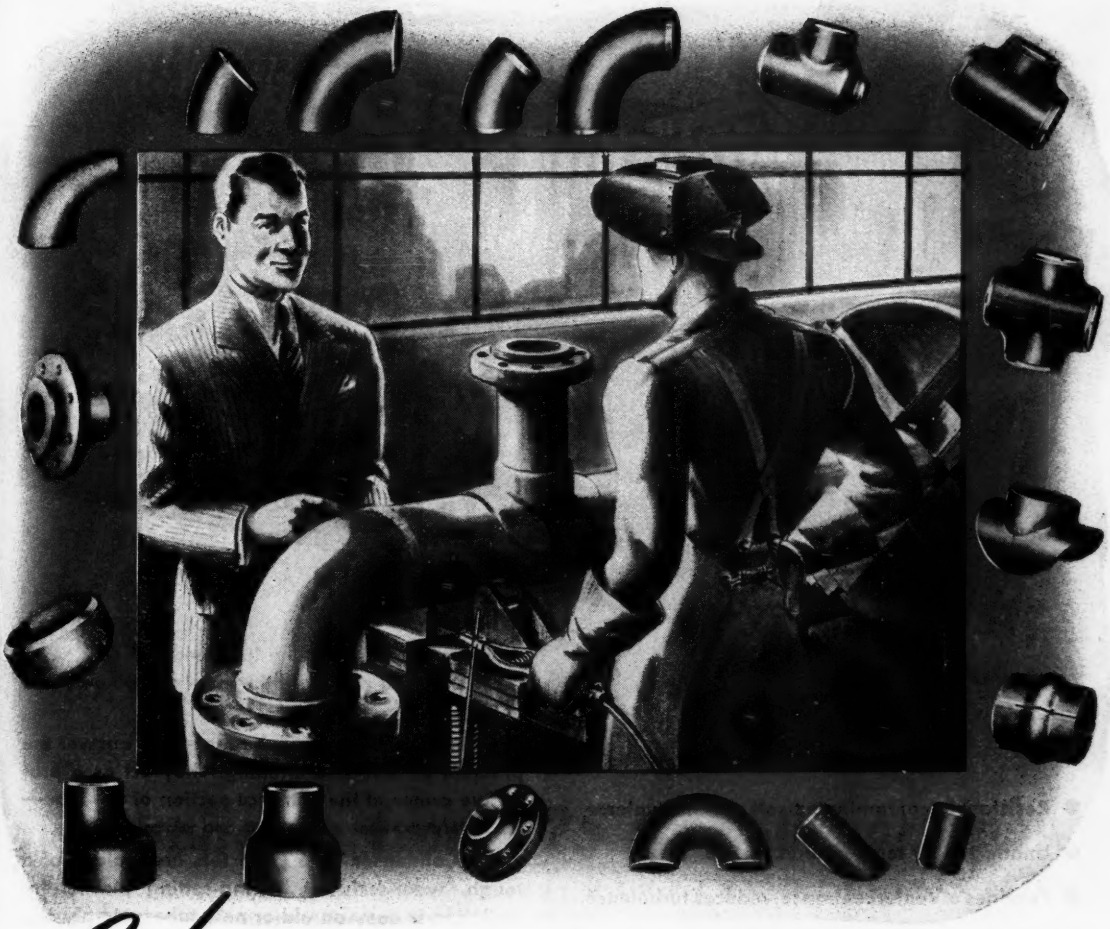
— The blades have large clearances and are double rim protected so that it is impossible for the blades to rub.

— Due to the generous blade clearances, it is not essential that frequent inspections of the thrust bearing be made.

For full details ask for Bulletin S-116.

T-1160

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



Ask **THE WELDER OF PRESSURE PIPING**

what he thinks of

MIDWEST WELDING FITTINGS

You will find that he gives them hearty approval. Piping welders generally have a high appreciation of the exceptional dimensional accuracy and uniformity of Midwest Welding Fittings . . . their job is easier and they can turn out better work faster.

Midwest Welding Fittings have extraordinary dimensional accuracy because particular precautions are taken in their manufacture. Midwest Welding Elbows, for example, are made slightly oversized, then reheated to forging temperature and given a final accurate sizing in compression. This provides accurate dimensions, true circular section, and uniform wall thickness. Comparative corrosion tests as well as tensile and ductility tests have proved the beneficial effect of forging the metal in compression.

Welders also appreciate the wide variety of Midwest Welding Fittings . . . including "Long Tangent" elbows and reducing elbows. There is a fitting for practically every condition he encounters. Ask the local distributor or our nearest office for Bulletin WF-41.

MIDWEST

PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

STOP THIS TUBE THINNING AND EROSION

Install JOHN CRANE CONDENSER TUBE PROTECTORS

Design Features

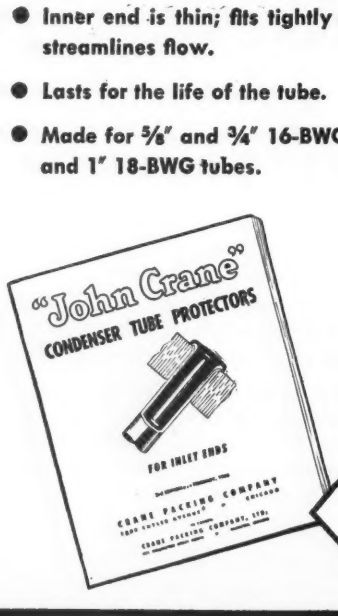
- Resistant to contaminated salt or fresh water.
- Unaffected by temperatures to 275° F.
- Provides a Venturi entrance; reduces turbulence.
- Inner end is thin; fits tightly against tube and streamlines flow.
- Lasts for the life of the tube.
- Made for ⅝" and ¾" 16-BWG, or ⅝", ¾", ⅞" and 1" 18-BWG tubes.

Provide an armor for the inlet ends of condenser tubes and you eliminate the most common source of tube failure.

John Crane Condenser Tube Protectors answer the problem of tube end thinning. They act as a protective armor at the entrance section of the tube—*absolutely prevent all erosion and abrasion.*

These Condenser Tube Protectors are molded of a tough, wear-resistant thermo-setting plastic. Installation is easy on old or new tubes; simply slip the Tube Protector into place, in most cases without removal of waterbox head.

Service Tests on many types of Marine and Stationary Heat Exchangers prove that John Crane Condenser Tube Protectors greatly lengthen tube life, saving critical metal.



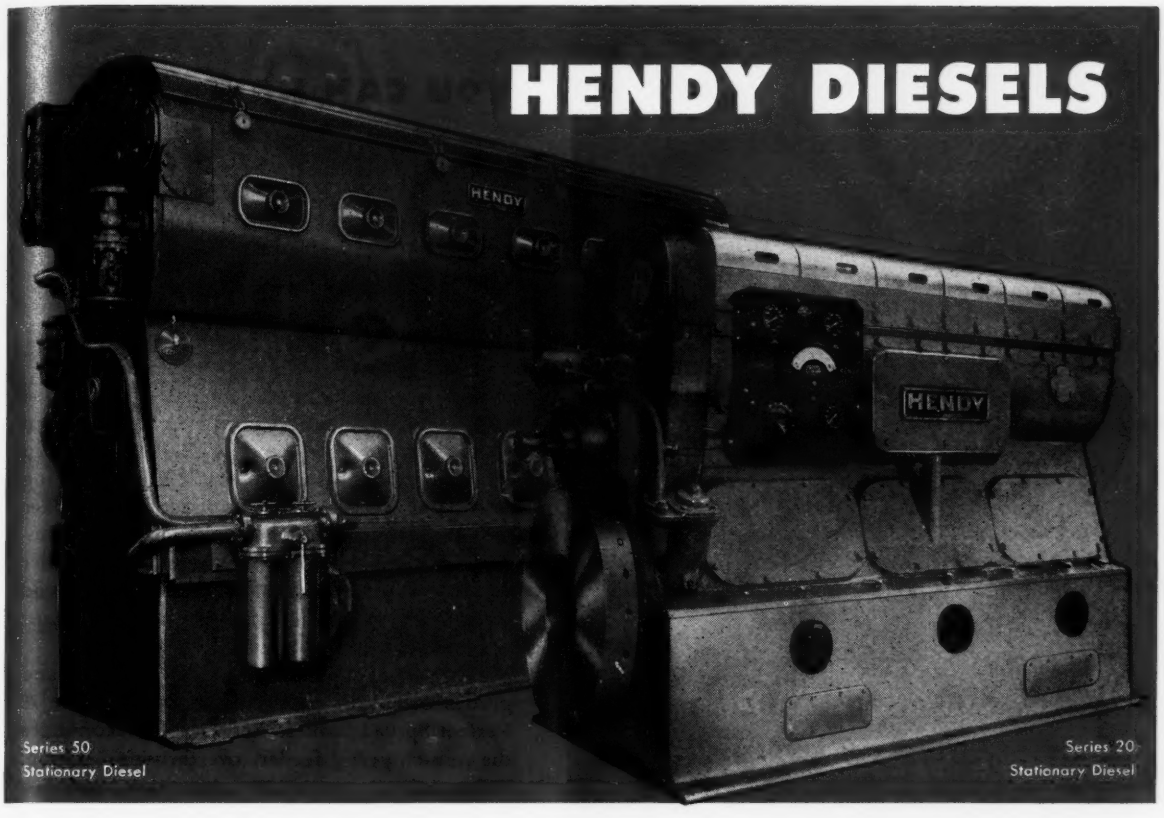
Power and Marine Engineers: Get the complete facts on the John Crane Condenser Tube Protector.

SEND FOR THIS BULLETIN

Typical Installation

CRANE PACKING COMPANY

1812 CUYLER AVENUE • CHICAGO 13, ILLINOIS



now available from 125 to 780 horsepower

Industrial operators are finding that in Hendy Diesels there is *more* than meets the eye. Besides their clean-cut appearance, they embody many features never before available in any one engine.

DEPENDABILITY: Unit-type fuel pumps and injectors eliminate high-pressure fuel lines and danger of air-locks. Overhead camshafts eliminate many moving parts and give quiet, reliable valve and fuel-pump action. Full pressure lubrication to moving parts assures the correct amount of oil at the right places, automatically.

ACCESSIBILITY: Fuel-transfer, lubricating-oil and cooling-water pumps, oil coolers, fuel and lube-oil filters are *conveniently* located and instantly accessible. Large inspection-doors, which can be removed without disturbing any other assemblies, give easy access to crankshaft and connecting-rod bearings.

LONGER LIFE: The conservative ratings and heavy-duty characteristics of these engines assure long life and smooth operation. The crankshaft, which is large and well proportioned, is supported by large, replaceable, bronze-backed bearings, all of which receive positive pressure lubrication.

JOSHUA **HENDY** IRON WORKS
ESTABLISHED 1856
SUNNYVALE, CALIFORNIA

GENERAL SPECIFICATIONS

SERIES 20
125 to 260 hp; 600 - 900 rpm; Air starting.

SERIES 50
350 to 780 hp; 350 - 500 rpm; Air starting; Dual intake and exhaust valves.

OPTIONAL EQUIPMENT
includes: Clutch power take-offs from either end; Engine-driven starting-air compressor; Closed-circuit cooling system.

Also available as complete generating plants.

Send coupon today for complete information and name of nearest Hendy representative. No obligation. Joshua Hendy Iron Works, Sunnyvale, California.

JOSHUA **HENDY** IRON WORKS
SUNNYVALE, CALIFORNIA

Please send illustrated catalog on Hendy Diesel engines. I am interested in engines up to 300 hp ☐; over 300 hp ☐; Diesel electric generating plants up to 225 kw ☐; over 225 kw ☐.

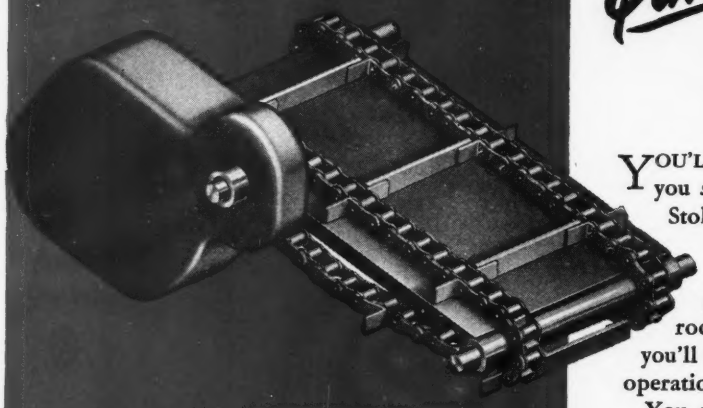
Name_____

Company_____

Street_____

City_____ Zone_____ State_____

96-D-19



ALL SPEED DRIVE GETS STEAM UP *FAST*

The Æ Perfect Spread Stoker answers steam demands instantly through a novel all-enclosed, adjustable-speed drive on the coal feeder. Automatic controls properly regulate the rate of feed and amount of forced draft to requirements—getting steam up *fast* and keeping it there!

YOU CAN HAVE *QUIET AUTOMATIC STOKING*

YOU'LL hardly believe your eyes or ears when you *see* and *hear* the new Æ Perfect Spread Stoker in operation. You'll see something entirely new and practical in stoker design. You'll see dependable, completely automatic stoking that ends boiler room drudgery and inefficient firing. And you'll be amazed at its *smooth,* unusually *quiet* operation.

You get maximum heat out of all kinds and grades of solid fuels, wet or dry, with the Æ Perfect Spread Stoker. Add to these economies the non-clogging feeder, overthrow spreading, "cross-firing" and other advantages, and you have a good idea how to produce more steam at lower cost.

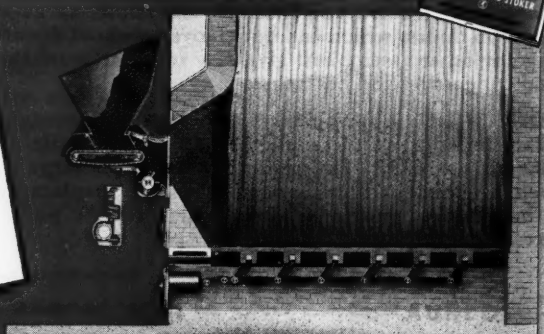
Other thrifty features and reasons why you should consider this stoker *now* are described in the new Æ Perfect Spread Stoker bulletin. Write for it today.

If Your Steam Requirements Call for 175 H. P. up to 200,000 lbs. per hour—

YOU NEED THIS BULLETIN

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

Æ PERFECT SPREAD STOKER



Other Æ Products: Æ-Taylor Stokers, [illegible]

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA.

Subsidiaries: COCHRANE [illegible] CORPORATION

SAFEGUARD YOUR DECISION WITH INFORMATION *NOW*

IF YOU'RE PLANNING a new stoker installation, can you afford to make a decision without knowing *all* the latest facts about *all* types of fuel firing equipment? Do you know, for instance, that great improvements have recently been made in Taylor Stokers?

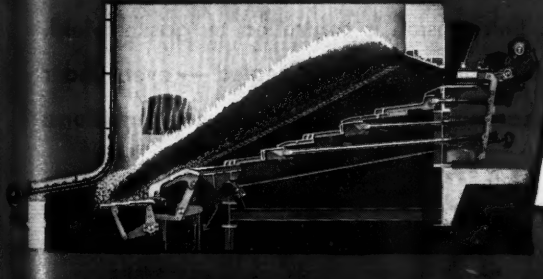
These are *basic* improvements in the tested Taylor Stoker principles of operation that have proved their value many times over during 39 years in hundreds of installations. Stoker design is now vastly simplified for more precise control of coal feed, combustion and ash discharge. Emphasis is placed on features that mean more economical, automatic operation for low cost steam generation under the widest variety of conditions.

All the advantages of the Improved Type "R" Taylor Stoker are detailed in a new, highly informative booklet. Be sure to have the facts before you when you specify power plant equipment. Write for this booklet *today.*

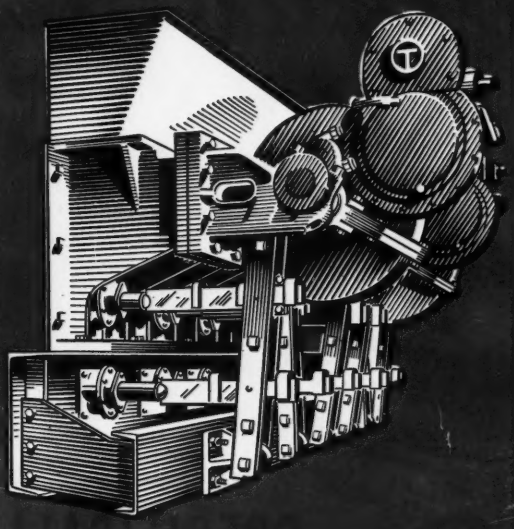
IF YOUR Steam Requirements Call for 20,000 to 500,000 lbs. per hour—

YOU NEED THIS BOOKLET

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.



ANOTHER IMPROVEMENT IN THE TYPE "R" TAYLOR STOKER



MORE EFFICIENT FIRING WITH STRAIGHT LINE DRIVE

Complicated mechanisms are eliminated from the improved Taylor Stoker front end drive, which means easier, more efficient regulation of coal feed and fuel bed movement. Simplified straight line drive of coal rams and secondary pushers increases efficiency and "on line" time.

Cooperate with the "National Fuel Efficiency Program" of the U. S. Bureau of Mines.

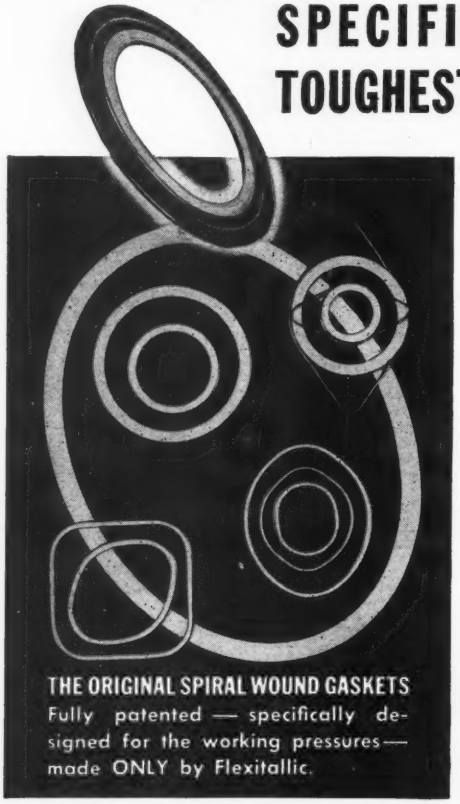
Æ TAYLOR STOKERS

AIR-COOLED & WATER-COOLED

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA.

SPECIFICALLY DESIGNED FOR THE TOUGHEST APPLICATIONS IN THE WORLD



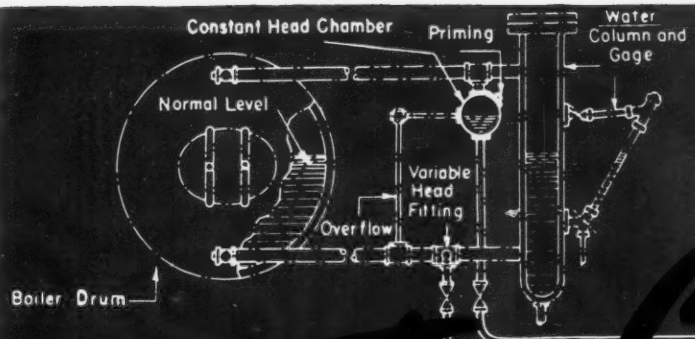
THE ORIGINAL SPIRAL WOUND GASKETS
Fully patented — specifically designed for the working pressures — made ONLY by Flexitallic.

No gasket in the world can match the Flexitallic spiral wound gasket in standing the terrific strains of naval and maritime operation! What's more, the ease of installing Flexitallic Gaskets means a 25 to 30% speed-up in pipe fabricating schedules. Only recently, Flexitallic Gaskets used on a critical large scale piping schedule resulted in a reduction of 2500 man hours — and this exclusive of time saved on pipe preparation!

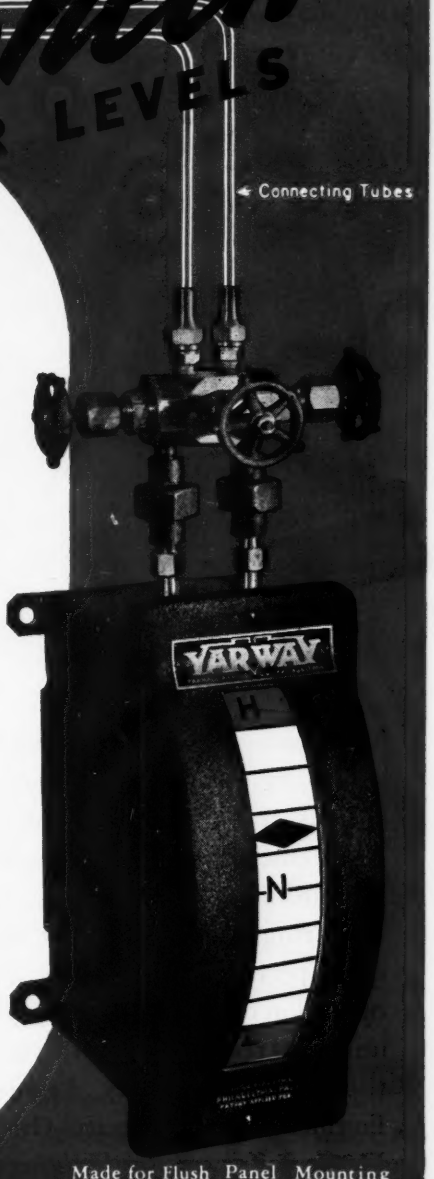
Spiral-wound Flexitallic construction automatically compensates for pressure surges, vibration, expansion, contraction. Bolt tension is controlled by gasket yield. Seal with Flexitallic and it stays sealed — even under the most hazardous wartime marine service conditions!

FLEXITALLIC GASKET CO. 8th & BAILEY STS. CAMDEN, N. J.

THERE'S NO MARINE GASKET PROBLEM FLEXITALLIC CAN'T BEAT!



Positive Check ON BOILER WATER LEVELS



Made for Flush Panel Mounting —or Wall Mounting (as shown).

RIGHT BEFORE YOUR EYES

No more guessing about boiler water levels! Now you can have a constant, positive check right before your eyes . . . on a brilliantly-lighted scale, on the instrument panel or at any other convenient place.

The Yarway Remote Liquid Level Indicator shows water level beyond the range of the overhead gage, and always indicates high or low—even when full or empty gages look the same.

It's accurate because it's operated by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. Indicating mechanism is never under pressure. Action is instant, constant, frictionless. *There are no stuffing boxes.* Mechanism is perfectly balanced on jewelled bearings outside the pressure chamber.

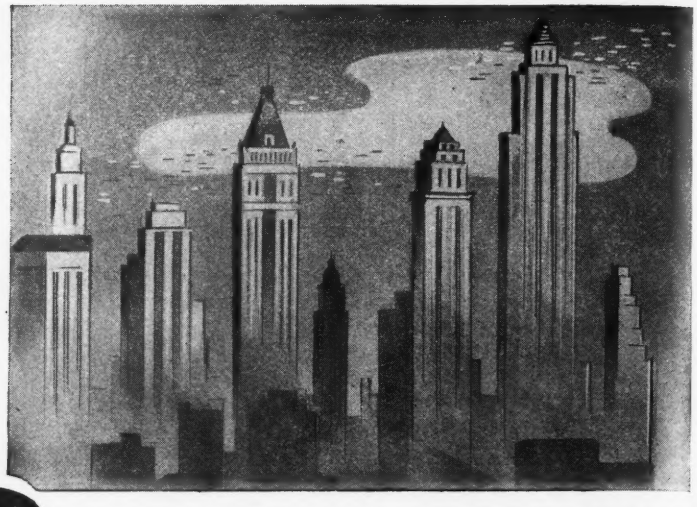
Yarway Remote Liquid Level Indicators are suitable for all pressures up to 1500 psi.

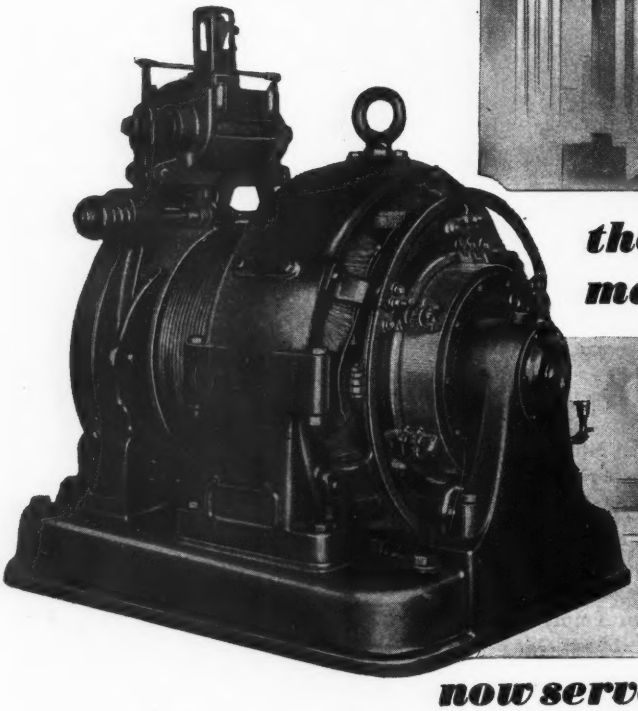
Already more than 2,000 have been bought. Ideal not only for boiler water level indication, but also to indicate superheater pressure differentials, feed-water-heater levels, and other liquid levels. Write for Bulletin WG-1820.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

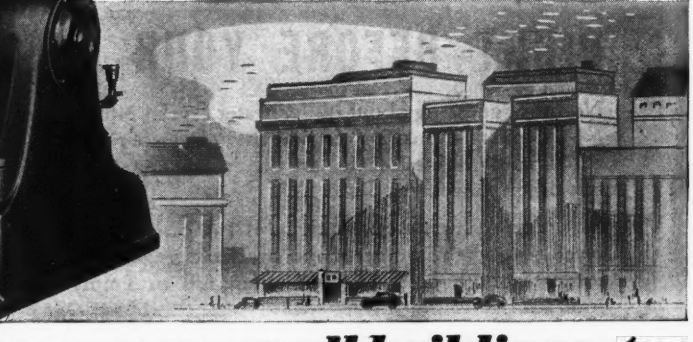
Ask about the new 30-minute color and sound motion picture, with Lowell Thomas speaking — available for group showings.

YARWAY REMOTE LIQUID LEVEL INDICATOR





the machine that helped make skylines . . .



now serves small buildings, too

The gearless elevator machine, first designed by Otis Elevator Company, was the result of a demand for faster and more efficient vertical transportation in tall buildings.

During the past 43 years, the smooth, quiet performance, and the economical operation of this machine have earned it universal recognition and acceptance. For these reasons, many Architects and Engineers today specify Otis Gearless Elevators *for smaller buildings* — whenever performance of outstanding quality is required.

Stores, Hospitals, Hotels, and many other buildings—whether of a few stories or many — can now benefit by the life-long operating smoothness and efficiency of Otis Gearless Elevators.

Otis representatives are ready now to cooperate with Architects and building owners . . . to recommend the equipment best suited to individual needs. For the finest in vertical transportation tomorrow, call your Otis representative TODAY.

Otis ELEVATOR COMPANY
OFFICES IN ALL PRINCIPAL CITIES

How to Get BETTER BRANCH PIPE OUTLETS At Less Cost

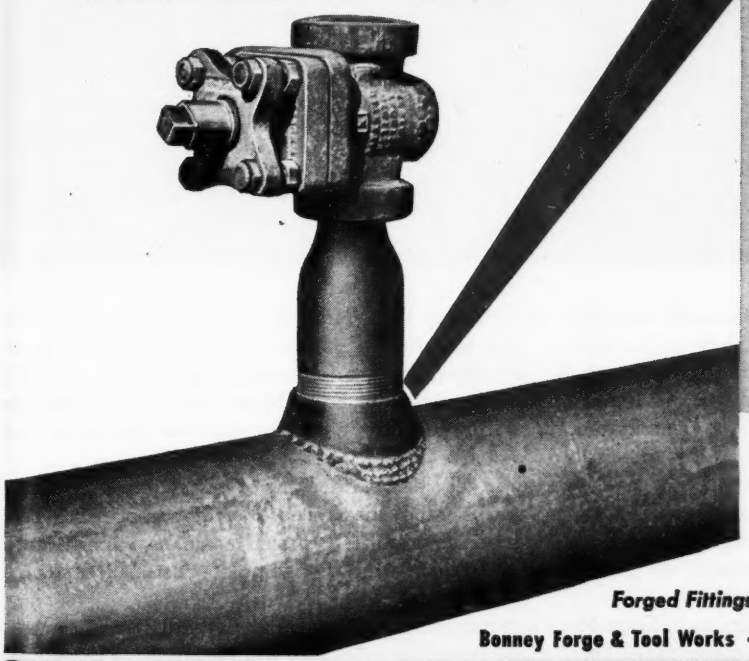
For easy-to-install branch pipe joints that are leakproof and provide original pipe strength, use WeldOlet fittings.

No matter what the branch pipe problem—new construction, shop fabrication or remodeling—the WeldOlet method saves on installation costs. No templates are needed. You don't have to thread the main pipe, or form and fit the branch pipe to it. All that plus unrestricted flow through the system.

For low first cost, easier and quicker installation and better branch piping jobs, rely on WeldOlet fittings. They are available in size-to-size or reducing sizes ¼" to 12". Ask for the latest catalog containing full information on all three types of WeldOlet fittings—with beveled outlets and socket outlets for welding or screwed outlets.

Only WeldOlet Fittings Give You ALL 5 ADVANTAGES

1. Low First Cost
2. Easy Installation
3. Original Pipe Strength
4. Unrestricted Flow Conditions
5. No Maintenance Worries



Typical installation of WeldOlet fittings with threaded outlets, used on a line carrying gas at 400 lbs. pressure.

Forged Fittings Division

Bonney Forge & Tool Works • 639 N. Meadow St. • Allentown, Pa.

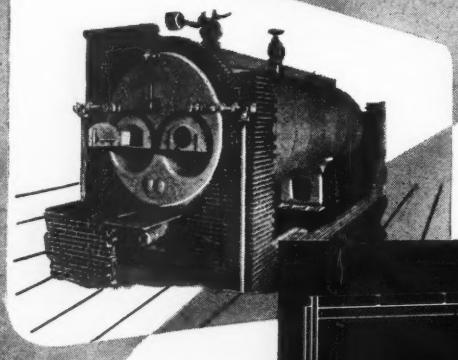
WELDOLETS

TRADE MARK REG. U. S. PAT. OFF. PAT. IN U. S. & FOREIGN COUNTRIES

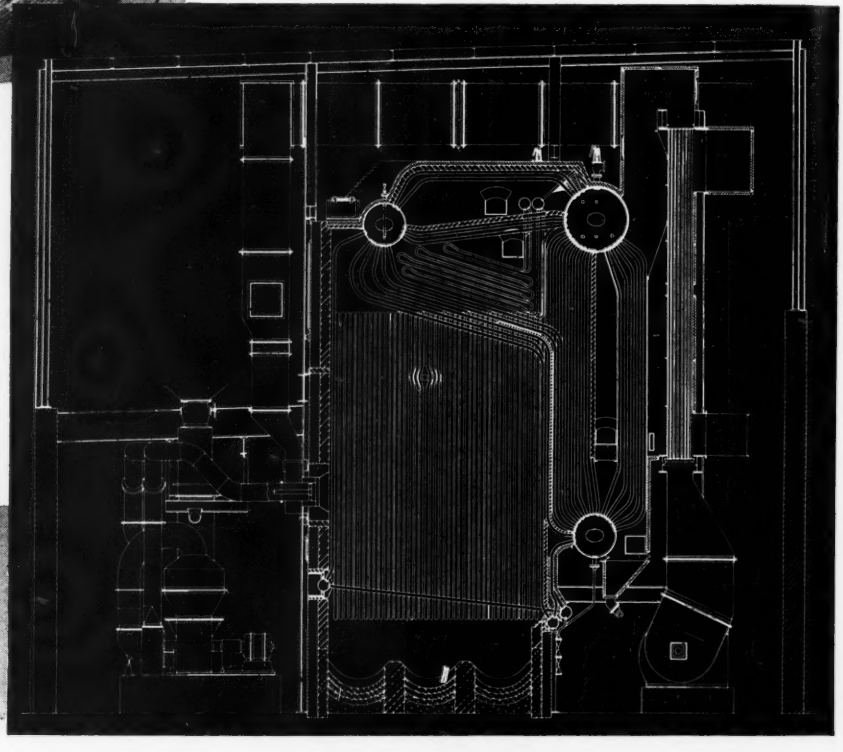
WELDING OUTLET - THREADED OUTLET - SOCKET OUTLET

For Welded Branch Pipe Outlets

Edge Moor
water tube boilers—



The Edge Moor Improved Galloway Boiler of the 1880's. It was described as "an internally fired boiler with two furnaces, uniting into one common central flue, which flue contains numerous conical tubes that cross the flue in nearly vertical lines."



Edge Moor radiant heat unit arranged for pulverized coal or liquid fuel firing. Equipped with superheater and Edge Moor vertical tubular air preheater. Capacity 75,000 lbs. steam per hour; Drum Pressure 465 psi; Degrees of Superheat 210° F.; Final Steam Temperature 700° F.

Down through the years since 1878, Edge Moor has continued to contribute to the store of knowledge and experience gained in the building of steam generating equipment. Modern demands are for continuous service and high ratings with maximum operating efficiency. Edge Moor meets these demands through a combination of skillful design, carefully selected materials and unsurpassed workmanship.

Edge Moor boilers are built in all standard designs of any required capacity, for drum pressures up to 900 lbs., and adapted to all methods of firing both solid and liquid fuels. Auxiliaries include water cooled furnaces, superheaters, economizers, air preheaters and steam washers. Complete installation service is available.

Inquiry as to Edge Moor's recommendations for your particular requirements will be given careful study, and complete proposals will be promptly submitted.

STEAM GENERATING EQUIPMENT

EDGE MOOR
IRON WORKS, INC.

BRANCH OFFICES: NEW YORK 20, N. Y.: 30 ROCKEFELLER PLAZA
CHICAGO 2, ILL.: ONE NORTH LA SALLE STREET

MAIN OFFICE AND WORKS: EDGE MOOR, DELAWARE

Ernst WATER COLUMN & GAGE CO.

Tel. Livingston 6-1400

250 SOUTH LIVINGSTON AVENUE

LIVINGSTON, NEW JERSEY

Manufacturers for More Than 40 Years

Specify:

Fig. 1
High and Low Alarm Column Equipped with Split - Gland Type Adjustable Inclined Water Gages.

Ernst

SAFETY

HIGH AND LOW ALARM

WATER COLUMNS

FOR

BETTER VISIBILITY

UP TO

900 PSI

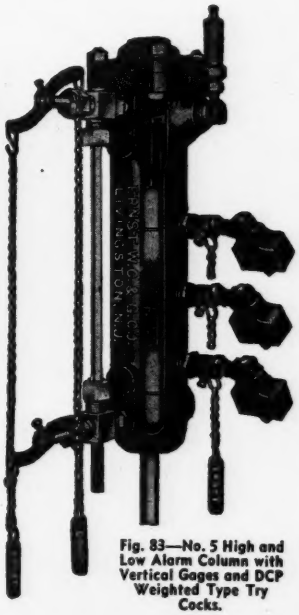


Fig. 83—No. 5 High and Low Alarm Column with Vertical Gages and DCP Weighted Type Try Cocks.

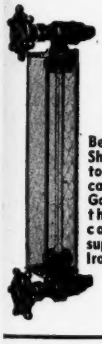


Fig. 9
Better-C Guard Shown attached to Ernst Vertical Forged Steel Gage Valves, these Valves can also be supplied in all Iron and Bronze.

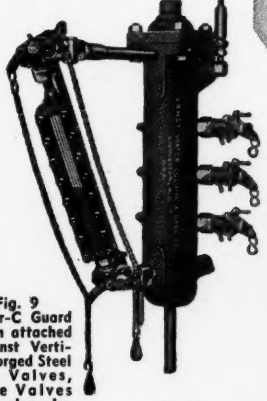


Fig. 32
Column Equipped with Prismatic Reflex Inclined Water Gage—Steam shows White, Water shows Black.

SPECIAL COLUMNS FOR HIGHER PRESSURES

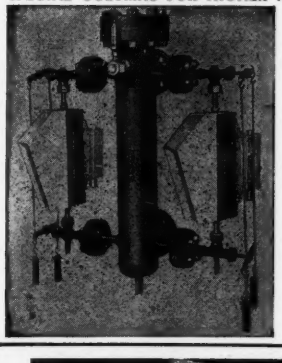


Fig. 85
High and Low Alarm Column Equipped with Two Gages and C-Clear Thru Inserts including direct vision Hoods.

Fig. 13
Leakless Super Try Cocks, Bronze and Forged Steel Construction.

Fig. 16

Sight Glasses for All Types Oil Cups and Lubricators

Fig. 17

Sight Flow Indicators for Insertion into Pipe Lines—All Sizes—

Fig. 12 Fig. 23 X Strong Fig. 14 Red Line

PRESSURE GASKET | COVER GASKET

GAGE GLASSES, ROUND AND FLAT TYPE, MICA SHIELDS, RUBBER GASKETS, NEOPRENE GASKETS, CORK WASHERS, SUPPLIED IN ALL SIZES, AND FOR ALL PRESSURES AND TEMPERATURES.

CARUBESTOS HIGH PRESSURE VALVE DISCS, ALL SIZES.

Shipments from Stock

Fig. 22—Standard Pattern Gaskets, High-Pressure, Non-hardening and Non-softening Series 750

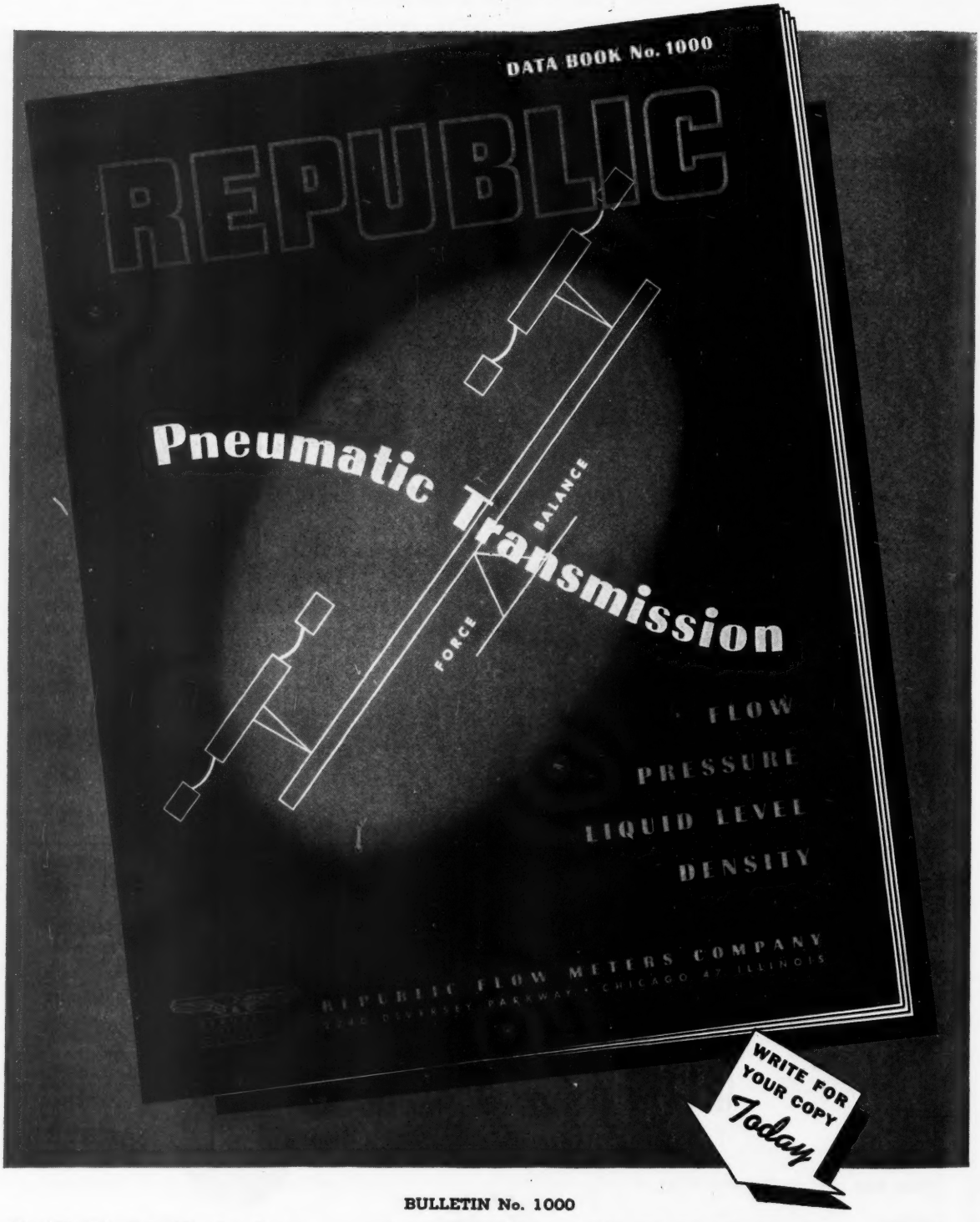
Fig. 21—Red Lip-Mold Pattern Expansion Type Gasket.

Cork Washer.

SEND FOR DESCRIPTIVE BULLETINS

Ernst — **ON LAND** — USED ALL OVER THE WORLD — **AND SEA** — **Ernst**

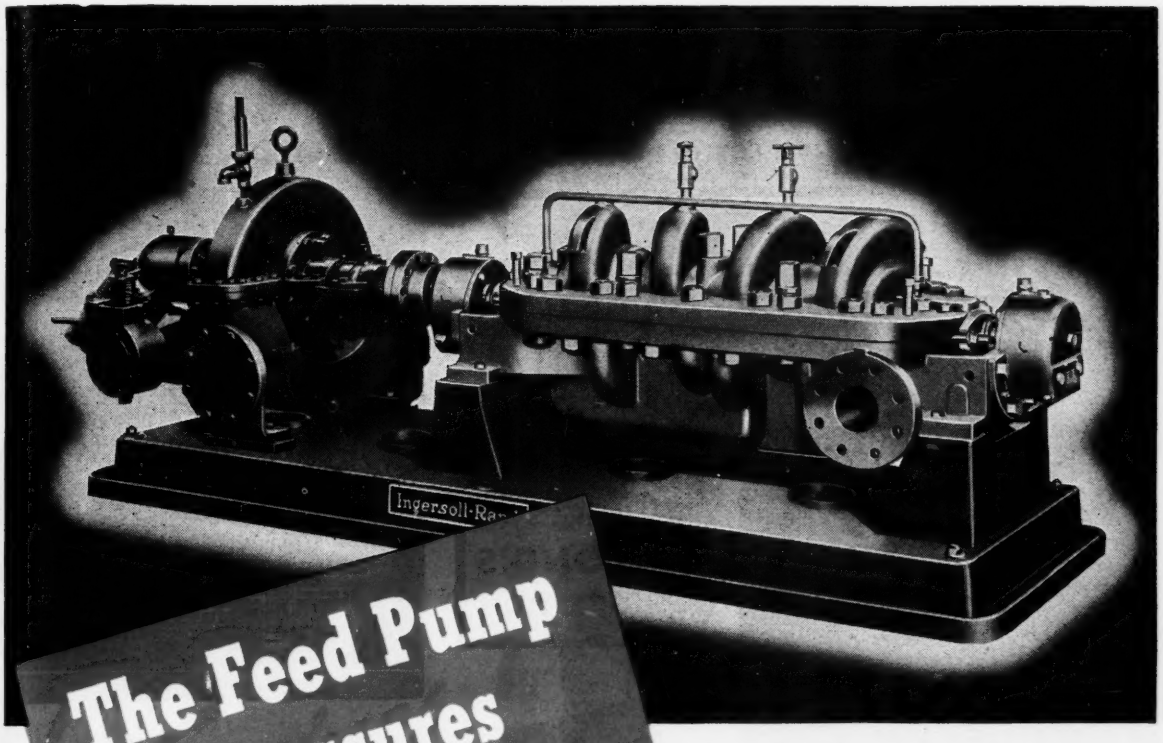
A NEW BULLETIN ON A NEW METER



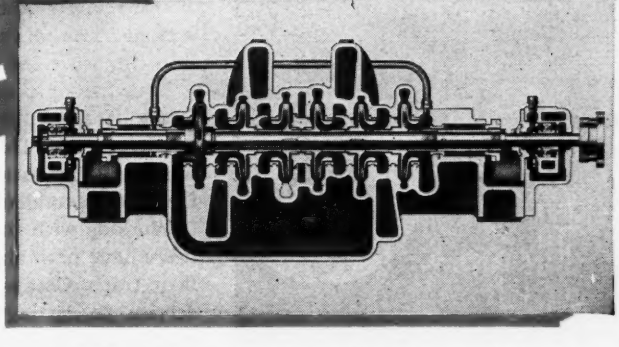
BULLETIN No. 1000

REPUBLIC FLOW METERS CO.

2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS



The Feed Pump for Pressures up to 800 lb.



Note simplicity of design and construction.

The Class CNT boiler-feed pump is an improved version of a multi-stage unit which has proved its efficiency and dependability in hundreds of land and marine boiler plants.

This new CNT quickly proved its stamina. Some of the features that make it an ideal boiler-feed pump are:

1. **It can be built of materials selected by the I-R metallurgical department to suit any type of boiler-feed water; yes, it is even available with stainless steel casing.**
2. **Extra large oil-lubricated bearings support the rotor. Ball bearings are standard; sleeve bearings can be furnished as an alternate.**
3. **The highly efficient impellers are mounted with opposed inlets and staggered discharge volutes to give complete hydraulic and radial balance.**

Let an Ingersoll-Rand pump engineer give you details of other features such as: the symmetrical design; extra-deep, low-pressure stuffing boxes; the sealed shaft sleeves; manufacturing methods and testing.

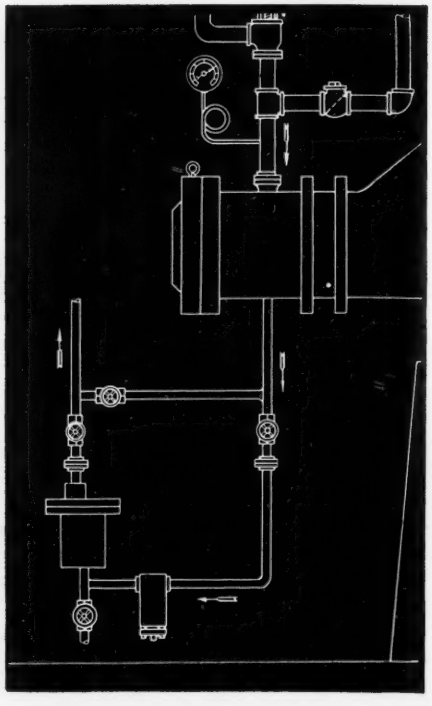
Class CNT pumps are available in capacities up to 700 gpm for pressures up to 800 psi. Other Ingersoll-Rand boiler-feed pumps are available for any and all boiler pressures in commercial use. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N. Y.

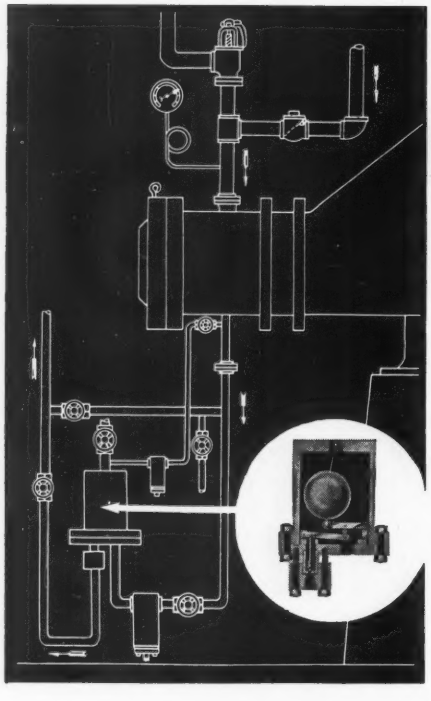
Ingersoll-Rand 10-631

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

PROBLEM: MORE ACCURATE TEMPERATURE CONTROL

What would you do?





HERE'S STRONG'S SUGGESTION

Latest refinery practices on reboiler and reflux unit installations include sensitive control instruments on steam supply to maintain the exact temperature required for precise "cuts".

Both Strong open and inverted bucket type traps discharge intermittently, providing a purging action as a part of the operating cycle. This feature, so desirable under most conditions, may result in instrument "lag" in time-temperature processes. On this job condensate must be drained *continuously*.

Working with the STRONG complete line—STRONG engineers have been able to recommend STRONG continuous flow float traps. Compact and dependable, these traps are now in service, permitting more precise "cuts" and insuring successful reactions in this important refinery production phase.

We Furnish the HOW as well as the WHAT WITH!

Steam systems will operate with many different types and applications of traps, reducing valves and other specialties.

They operate best only when the *right* units are installed to *best* advantage. That calls for intimate knowledge of your problem, experience with all types of steam specialties—and a complete line to give you the benefit of the unbiased recommendation.

Strong engineers are always ready to help. You can be sure that their recommendations will be backed by long experience with the complete STRONG line, including open and inverted bucket, closed float, float - and - thermostatic (blast) traps, etc.—forged, fabricated (welded) cast and semisteel construction. Send your problems to Strong, Carlisle & Hammond Company, Cleveland 13, Ohio.

STRONG, CARLISLE & HAMMOND COMPANY
Cleveland 13, Ohio

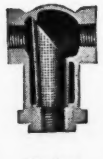
REG. TRADE MARK

OTHER ANUM-METL Reg Trade Mark

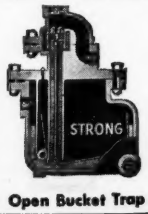
STRONG

STEAM SPECIALTIES

Reducing Valves



Strainer



Open Bucket Trap

The Problem
① To unload power plant coal from either rail or economical river barge transportation
② Deliver to existing coal storage system above boiler-room
POWER PLANT
COAL BARGE
THE S-A ANSWER
Two-Fold Savings
BELT CONVEYOR
FEEDER

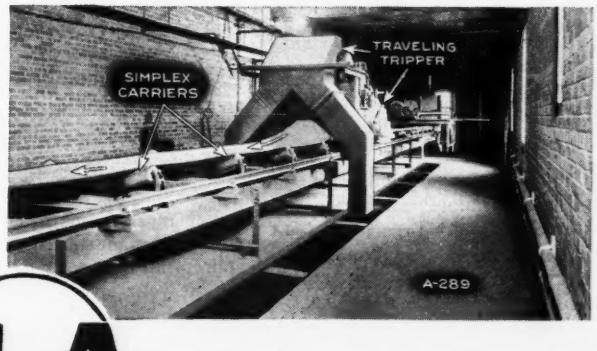
The belt conveyor from water front loading hopper to building is operated at maximum practical angle to reduce the height of the hopper. The crane shown can unload from either barges or cars.

★ ★ ★

Here's another outstanding case where S-A engineers worked out a practical, efficient system in answer to a specific problem. This power plant wanted to cut coal handling costs by bringing coal in by barge.

The S-A system shown was the logical economical answer . . . with *double savings* for the company: (1) It permits fast handling of coal brought in by rail or more economical water transportation, and (2) it makes use of existing coal handling equipment . . . keeping new equipment and installation expense to a minimum . . . Simply a Hopper, Reciprocating Plate Feeder, and inclined Belt Conveyor, all fed by a crane which can dip into either barge or car for its load.

S-A Belt Conveyor and self-propelling, self-reversing Belt Tripper to distribute coal to all parts of overhead boiler room bunker.

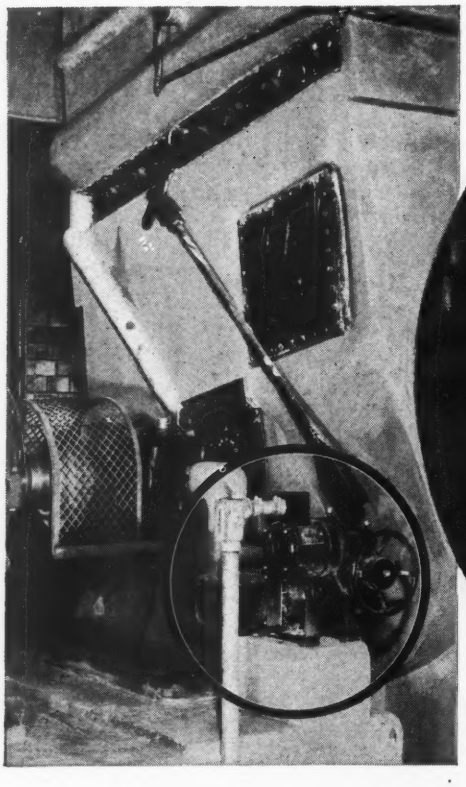


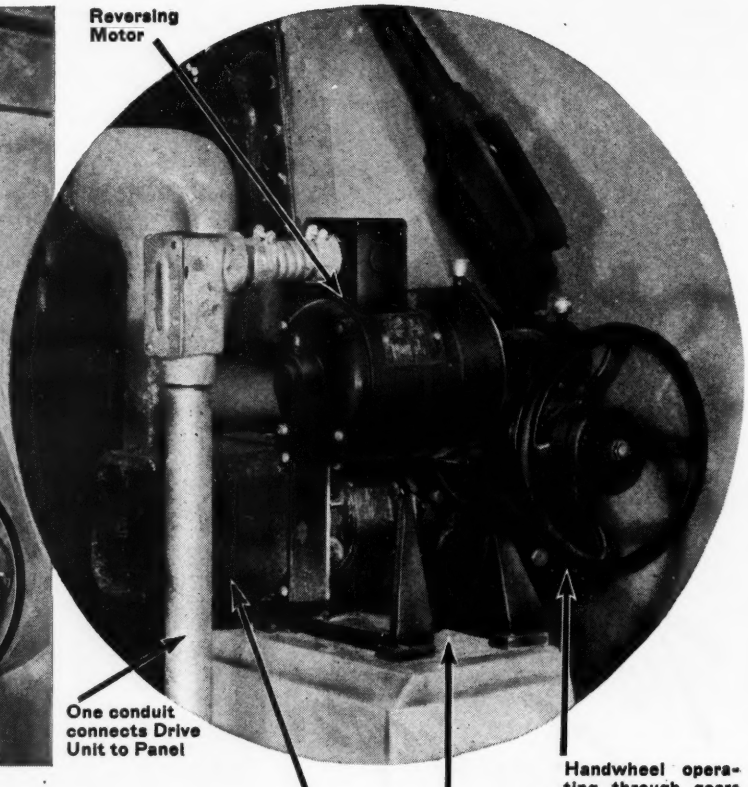
STEPHEN S-A ADAMSON MFG. CO.

515 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

BULK MATERIAL HANDLING EQUIPMENT




Reversing Motor
One conduit connects Drive Unit to Panel
Handwheel operating through gears gives one-man manual control even on heavy dampers or vanes
Reduction train can't be back-driven; locks itself, eliminating lock and release devices
Adjustable Limit Switches stop elements at desired points and/or interlock them with other elements

This DRIVE UNIT Idea . . .

CAN YOUR BOILER PLANT PROFIT BY IT?

Many of the advantages which power-plant engineers find in L&N Combustion Controls are due to the Electric Drive Units which move the dampers and other controlled elements. The simplicity and dependability of the units make them fit well into the needs of any power plant.

Fuel Engineers and Boiler Operators like L&N Electric Drive Units because:

1. They move dampers, etc., smoothly and accurately. Unbalanced elements can't back-drive Units; each remains locked in place until the Controller calls for another adjustment.

2. Remote manual control is accomplished by simple push-button stations at the Panel. Transfer to and from Automatic Control is by a single Selector Switch, for all Units.

3. Continuity of Drive Unit operation depends only on the station's electric supply.

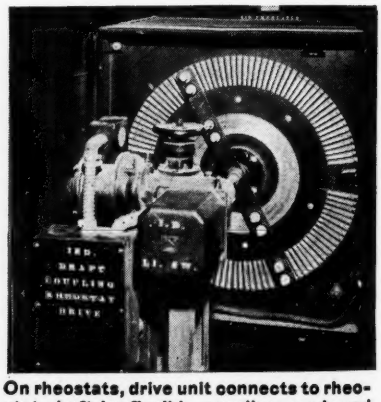
4. Units always receive full power; electric wiring is not subject to plugging or freezing.

5. Units can always be moved through handwheels. Reduction gears make this easy and also prevent unbalanced elements from snatching the wheel from the operator.

Design & Construction Engineers like the fact that Drive Units use only electric power. No prefabricated mounting stands. Units need only concrete or steel bases.

Maintenance Engineers find the attention required consists mainly of occasional cleaning and oiling.

We make Combustion Control to meet any plant's need and will send appropriate catalog if you'll briefly outline your layout. Or an engineer will be glad to call on request.



On rheostats, drive unit connects to rheostat shaft by flexible coupling—rack and pinion eliminated. Drive units fit any plant layout.

Jrl. Ad NU92(1)

depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

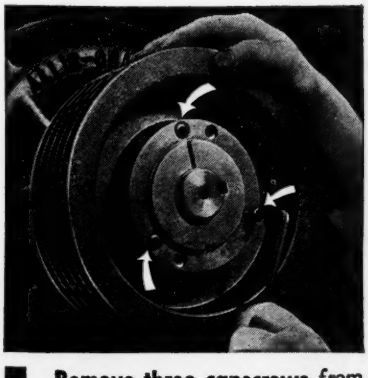
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Changing was a job for but now could do it

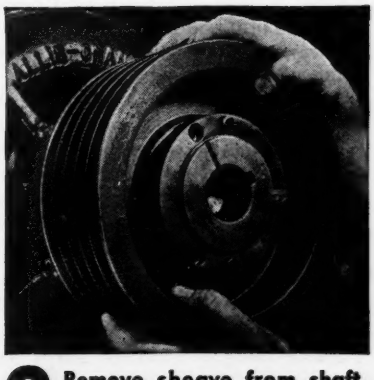
No bulging muscles needed! Allis-Chalmers' new "Magic Grip" — *fastest mounting and demounting sheave on the market* — slides on and off *easily!*

SEE HOW QUICKLY AND EASILY THIS SHEAVE COMES OFF THE SHAFT



1 **Remove three capscrews** from bushing collar. A handy wrench — supplied with each sheave — is the only tool needed to remove Allis-Chalmers' new "Magic-Grip" from motor or machine shaft quickly and easily.

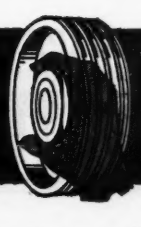
2 **Insert two capscrews** in tapped holes. As screws are turned, they become levers . . . automatically breaking tight grip of tapered split bushing on sheave and shaft. Entire unit is then ready for removal.

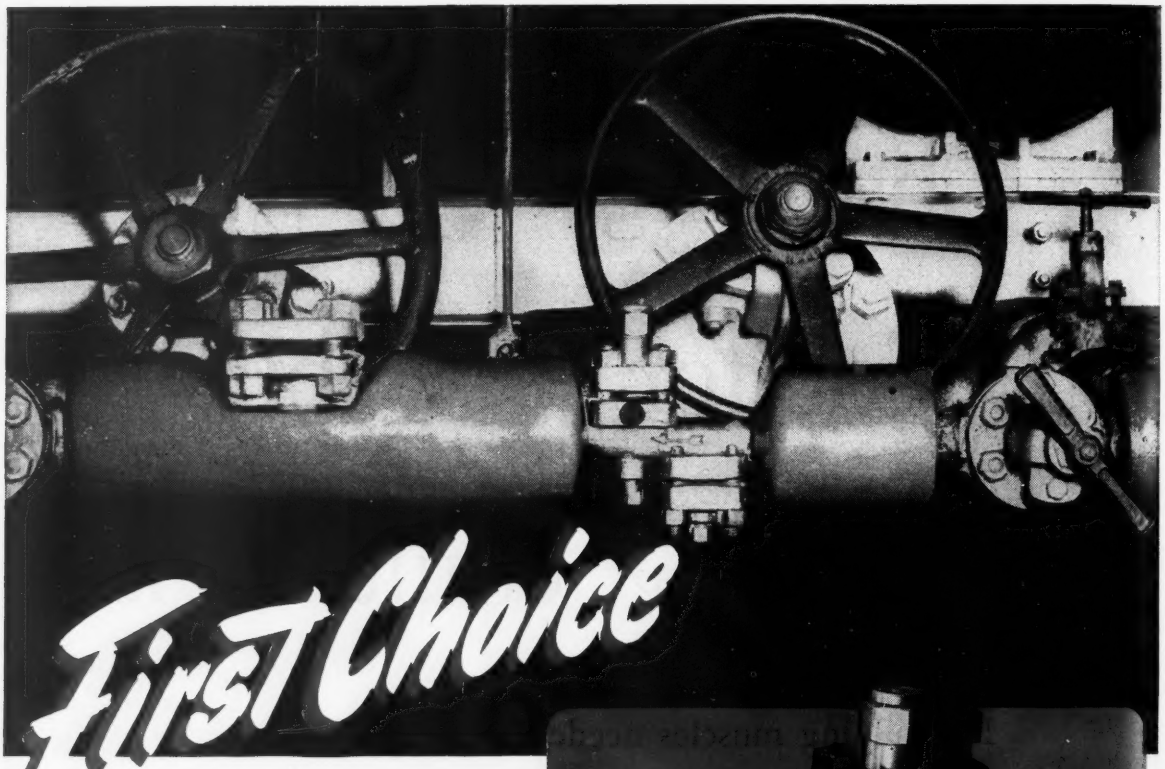


3 **Remove sheave from shaft.** Requires no mallet, no prying, no bulging muscles. You just slide the sheave off . . . smoothly, quickly. *It costs nothing extra!* Send for B6310. Allis-Chalmers, Milwaukee 1, Wis.

A 1856

Allis-Chalmers Texrope

"MAGIC-GRIP"  SHEAVES



First Choice

FOR TRAPPING HIGH PRESSURE LINES

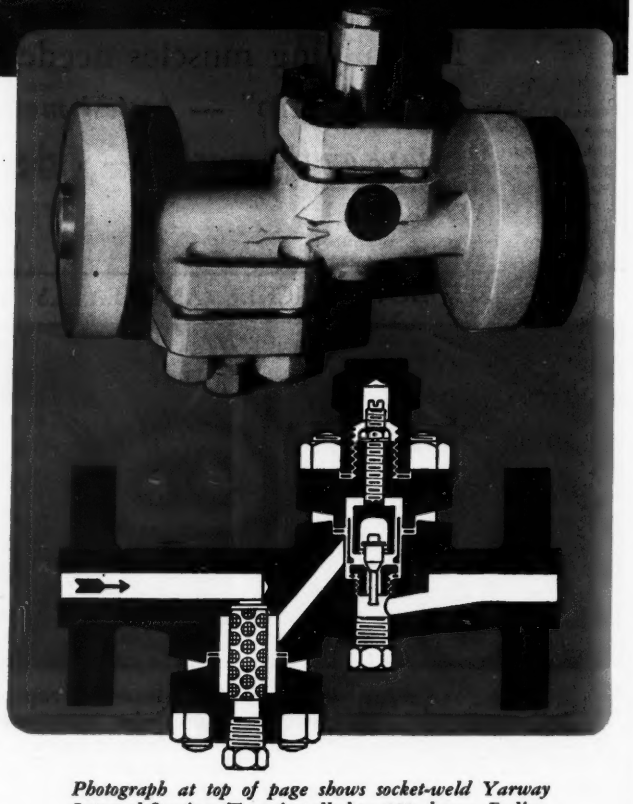
Yarway Impulse Steam Traps are favorites for trapping requirements on pressures up to 1500 psi.

At the Westport Station of Consolidated Gas Electric Light and Power Company of Baltimore, Yarway Integral Strainer Traps are used to drain some of the hottest steam lines in the country —900 degrees F. at a pressure of 1250 psi. These "super" Yarways have ample condensate capacity when system is being "warmed up" . . . will handle relatively small amounts of high temperature condensate without losing prime. In the presence of dry or superheated steam the main valve closes positively.

Small size makes installation easy. Integral strainer feature adds protection, simplifies both installation and maintenance.

Yarway Integral Strainer Traps have the same simplicity of design as standard Yarways—only one moving part, a stainless steel heat-treated valve.

Over 400,000 Yarway Impulse Steam Traps have already been sold. Write for complete Bulletin T-1739.



Photograph at top of page shows socket-weld Yarway Integral Strainer Trap installed on 900 degree F. line. Illustrations immediately above show flanged-end design.

YARNALL-WARING COMPANY · **114 Mermaid Ave., Philadelphia 18, Pa.**

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

The Lost Generations of Engineers

By WILLIAM B. PLANK

Professor and Head, Dept. of Mining and Metallurgical Engineering, Lafayette College, Easton, Pa.

WHILE the energies and interest of the entire country have been centered on winning the war against Germany and Japan, two very important and significant educational considerations seem to have been overlooked by those who are planning for the successful culmination of the war in Europe and in the Pacific, and for the expected rapid development or reconversion of our industries after the fighting stops.

It is eminently right and proper that all elements of our society should make their respective contributions to the winning of the war, and I have no criticism whatever of any government agency which has had to put the common welfare and safety above the interest of any group.

It cannot be denied, however, that the successful prosecution of this war, more than of any other war in the history of the world, depends absolutely on the continued, phenomenal production of our American industries which, through the inventive genius and special skills of our American engineers, with the loyal support of labor, have produced and are producing the guns, ammunition, ships and armament that have made our Armed Forces invincible on all fronts.

In addition to the engineers in industry, the Armed Forces who are winning our battles against the enemy so magnificently, would be helpless without the peculiar, specialized, and brilliant abilities of the engineers in the uniforms of the Army, the Navy, the Marines, the Air Forces, and the Merchant Marine.

The Present Supply of Engineers

With these facts well-known and acknowledged by everyone, educators, whose job it is to train these engineers, are beginning to be alarmed at the present situation affecting the immediate and future supply of engineers to fill these absolutely vital functions in our nation's existence.

The two points in this situation that seem to have been overlooked are that: (1) Unless we begin immediately to make it possible for qualified young men to complete their formal engineering education, there may well develop a critical shortage of engineers in the Armed Forces with a resultant prolonging of the war; and (2) Even though we begin at once to train engineers, the vacancy in the normal supply of engineers from our engineering colleges will never be filled, and the expected development of our industries after the war consequently may not be fully realized.

Who Are the "Lost Generations"?

It is these "lost generations of engineers" about which I wish to speak particularly. They are the men who, because of Selective Service, were prevented from completing or, in many cases, even beginning their formal education at the 150 or more engineering colleges of our country. They are, for the most part, in the uniforms of our Armed Forces. Although they may have received specialized training in the Army or Navy, their complete professional engineering education has been stopped, or at least seriously interrupted.

Ever since the Selective Service began to operate, especially after Pearl Harbor, the enrollment in the engineering colleges has been steadily dropping. In 1941-42, there were 115,000 engineering students in the engineering colleges of the United States and Canada, as compared with 42,000 today. This is a drop of 64 per cent in three years.

What is more alarming, however, is that the number of students who may receive their engineering college degrees this spring will be only about one-fifth the number that graduated two years ago. In 1942-43, there were 14,714 men graduated in engineering in the U. S. and Canadian colleges, whereas there are only 3,000 senior engineering students in college today, and not all of them will likely receive degrees, for one reason or another. In normal years, between 12,000 and 15,000 engineering college graduates annually took their places in the industries of the U. S. and Canada.

Are Veterans Flocking to Engineering Colleges?

The common belief that the returning veterans will flock back to the engineering colleges in large numbers appears not to be borne out by studies made by educational authorities. It is estimated that about 60,000 veterans might be expected to apply for technical and engineering training, but not all of these will likely want to take the time to complete professional engineering courses.

From the partial picture we now have of the educational desires of the veterans already returned to us, it is seen that, for the most part, they will want short, special, intensive training courses to fit them for a job as soon as possible. This kind of training will likely be given largely by the colleges in industrial communities where the veteran can work at a job during the day and go to school at night.

The type of institution best suited for this work is the so-called Technical Institute, where the objective is the training of technicians for industry, or the upgrading of them in occupations for which professional engineering school graduation is not required. This type of training is admirably fitted for immediate productivity on completion of the training program, and for the attainment of occupational goals sooner than is normally the case with graduates of engineering colleges.

Technical Institutes

From a recent study of vocational-technical training made by the U. S. Office of Education, it was estimated that, on the average, industry needs 5.2 technicians for each engineer. There are not enough technical institutes at present to train all the technicians that are estimated to be essential for industry in the post-war days.

The study shows that not less than 250 of such institutions will meet the needs of the country, and that there should be one in each community of 50,000 or more.

It is the opinion of many educators, with whom I concur, that the professional engineering colleges should not attempt to provide the technical institute type of training because they do not have the proper facilities nor the staff to do the work well.

These colleges, in my opinion, should now be planning for the professional engineering training of the young men now in secondary school. According to one estimate made last fall, three out of every four high school seniors expect to go to college and 43.4 per cent of these are planning to study engineering. The other choices in order are: medicine, law, business administration, agriculture, and physical education.

The effect on our national life of the absence of the "lost generations of engineers" can never be fully remedied.

Republished in full from May 1945 issue, Journal of Engineering, Education of the SPEE.

Design of SMALL POWER PLANTS

Thousands of small industrial power plants in this country are dead ripe for extensive remodeling and rehabilitation. In the keen post-war economic competition ahead, small industrial establishments must continue to produce for themselves the necessary power plant services to processes—heating and process steam, hot and cold water, refrigeration, etc., and by-product electricity—since they can seldom find ways of purchasing them except for electricity. Hence, to assure continuity of service and utilize their fuel dollars to best advantage, they need to "take steps." The author and his associates have had many years of experience in analyzing and improving conditions in such small power plants. Here is a summary of the things that must be considered, the author says, if engineers and industrial executives are to get the right answers to some very important post-war problems.

By

H. C. Carroll

Commercial Testing & Engineering Co., Chicago, Ill.

ACCORDING TO a recent report of the Federal Power Commission, showing 18,500 establishments reporting under the heading of Manufacturing Plants, the consumption of electricity has more than doubled since 1939. The privately owned generating reporting establishments in the same category increased 21 per cent over the same period.

During the present war effort, not too much attention has been paid to the economics of private industrial plant electrical generation, the main object being to produce the goods at any cost. When such plants return to normal operation at the conclusion of the war, and have to meet keen post-war competition, what will be the guiding factors in the operation of these plants, or their redesign, where necessary?

The main reason for the existence of electrical generation in manufacturing plants of the type shown in Figs. 1, 2 and 3 is that in serving the different facilities, such as space heating, high and low pressure process work, hot water, refrigeration, etc., the steam can be used to generate power while reducing it to the desired pressure and temperature for the varied uses. In other words, the generating equipment serves as a reducing valve, and the generation of current becomes a by-product of this operation.

Analysis Must Start with Heat Balance

In determining the economics of any investment in electrical generation in a manufacturing plant of this nature, the fundamental requirement is that a plant heat balance, of the general type shown in the table, must first be made or carefully calculated, covering a full cycle of operation.

From an initial inspection of the plant it should be determined that there exists a good possibility of a saving from such a study and heat balance. In some cases it may be quite apparent that there exists little relation between steam demand and

TO REVAMP OR DESIGN SMALL POWER PLANTS, CONSIDER:

(1) Heat balance of plant fundamental to obtain correct data for design
(2) Quantity determination of all services rendered by the plant
(3) Evaporative tests on steam generating unit or units necessary to establish efficiency, ratings, and coal adaptability
(4) Graphs showing complete operation, to determine if electrical generation is feasible and economical
(5) Full knowledge of fuels commercially available to plants, their characteristics, analysis, etc., needed in plant design
(6) Selection of steam generating unit, based on lb of steam per hour rather than on horsepower; depends on characteristics of load, fuel, and selection of fuel burning equipment. Limitations in specifications necessary for competitive bids
(7) Selection of fuel burning equipment depends on design of complete unit, and characteristics of load and fuel
(8) Advisability of heat recovery apparatus should be based on return of investment
(9) Necessity of good rugged combustion control emphasized
(10) Feedwater treatment should receive study for proper solution
(11) Coal and ash handling limited to return on investment when coal consumption is large enough to warrant it
(12) Electrical generation designed to fit heat balance
(13) Partial purchased power, when available, is economical under some conditions
(14) Records vital to maintaining efficiency

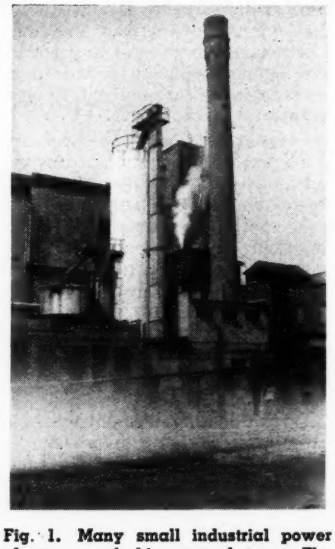


Fig. 1. Many small industrial power plants are of this general type. The silo is for coal storage

Complete text of paper delivered under sponsorship of ASME at Joint Fuels Conference of AIM & ME and ASME, Charleston, W. Va., October, 1944. Published by permission of the ASME.

Illustrations courtesy of the author, except as indicated; many of them taken by Osborne Monnette of CT&E Co. staff.

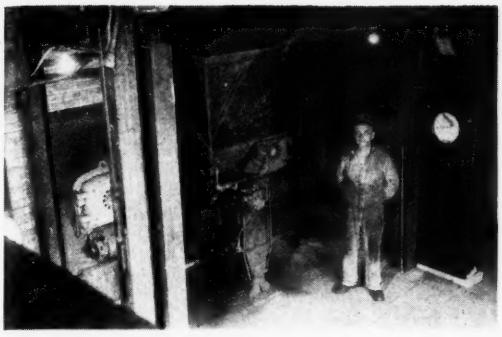


Fig. 2. A small plant boiler room can give good service without being too elaborate

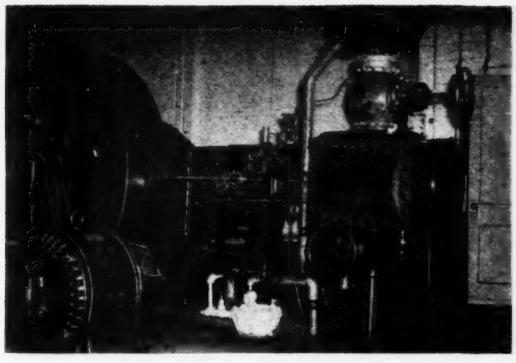


Fig. 3. When well operated and maintained, veterans like this one have been invaluable in carrying the war production loads

electrical demand, as in the case where space heating is the only steam demand, and that of a seasonable nature. The investigation should show the generation and distribution of steam requirements, covering all the services rendered, such as steam for the different processes, hot water heating, and seasonable space heating. This can be well shown on a flow diagram as in Fig. 4.

Instruments for Heat Balance Data

Few of the smaller plants have all the permanent instruments or facilities for such determinations, and except for fuel used, its cost, labor, maintenance, and such items of expense, data are lacking for computing a plant heat balance. It becomes necessary, then, to measure these quantities over long enough periods

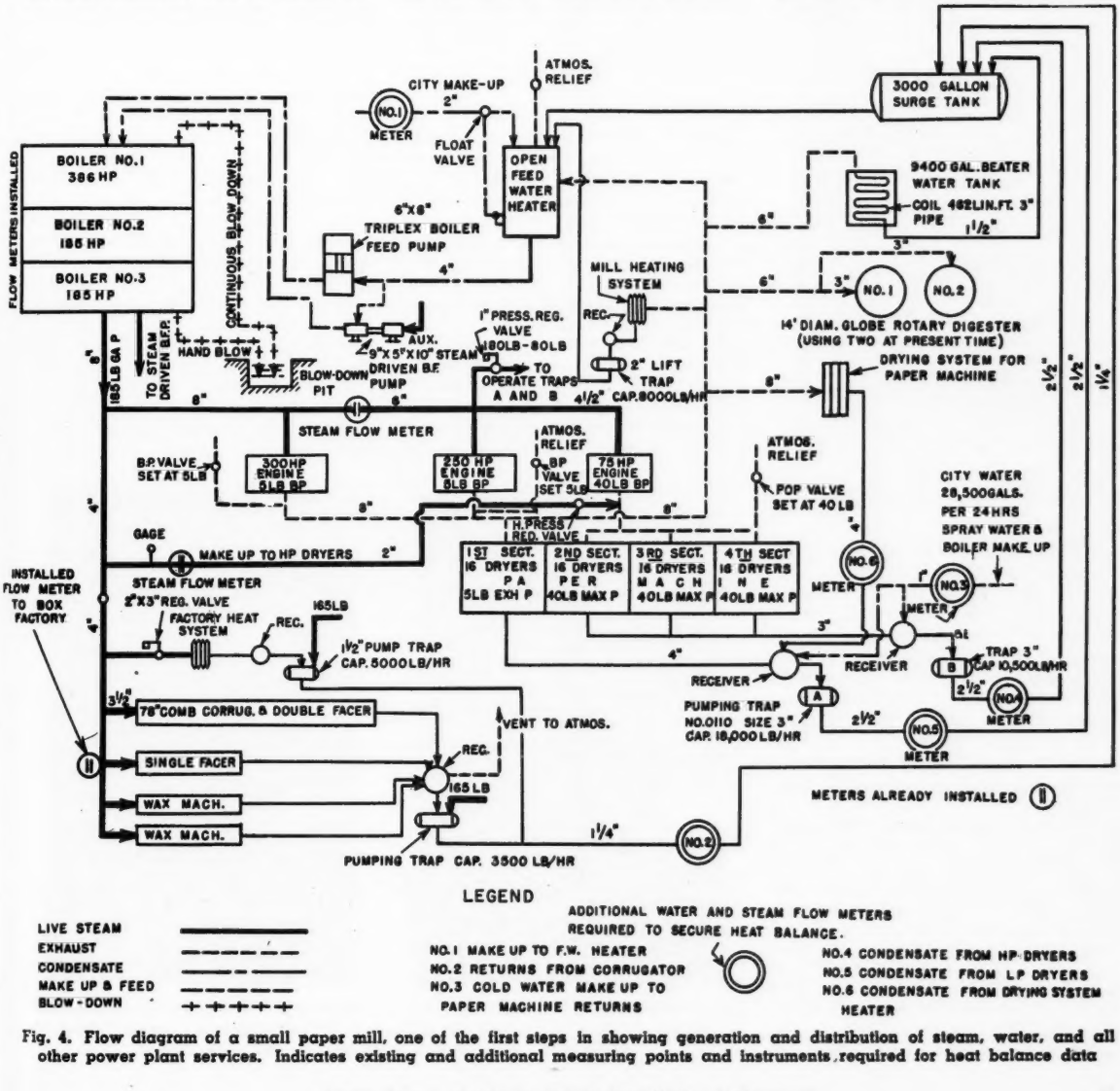


Fig. 4. Flow diagram of a small paper mill, one of the first steps in showing generation and distribution of steam, water, and all other power plant services. Indicates existing and additional measuring points and instruments required for heat balance data

Tables showing how information obtained from measurements in power plant and industrial processes of Fig. 4 is tabulated under various headings to work out complete heat balance. Make-up water is a particularly important item, affecting many details of plant design and operation

HEAT BALANCE—HIGH PRESSURE STEAM

Total Steam Generated Lb.	Steam to No. 1 Eng. Lb.	Steam to No. 2 Eng. Lb.	Steam to No. 3 Eng. Lb.	Steam to Box Factory Lb.	40-lb. Steam to Paper Mach. Lb.	Steam to Auxiliaries Lb.	Steam Unaccounted for Lb.

HEAT BALANCE—LOW PRESSURE STEAM

Available L. P. Steam No. 1 and 2 Engs., Lb.	Available 40 lb. Steam No. 3 Eng. Lb.	Available 40 lb. Steam Thru Red. Valve Lb.	Total Exhaust Steam Available Lb.	Total Steam to Paper Mach. Lb.	Pounds Paper Produced Lb.	L. P. Steam Unaccounted for Lb.	Lbs. Steam per lb. Paper Lb.	Make Up Lb.	% Make Up

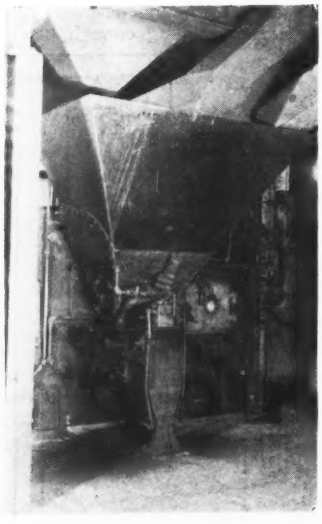


Fig. 5. Small underfeed stoker of type well suited to many small plants

to establish figures that can be used in setting up a year's operation. This may be done as shown.

For measuring water quantities, calibrated hot water meters of the vortex type are used, which show little variation over their whole range of calibration.

For steam measurement, portable chart recording flow meters are installed in the principal supply lines, and 24-hour charts are obtained, from which planimeter measurements for quantity are determined. The value of the recording charts for this work is that they indicate not only the total quantity of steam used, but also the characteristics of the load on the particular department served.

Why Make-up Water Is Important

One of the most useful and informative measurements found in plant investigations of this nature is the measure of the make-up water to the steam generating plant. By calculation of blowdown, usually through a continuous blowdown system, the resulting make-up represents the loss in the system cycle, and further determinations can be made to ascertain whether they are avoidable or unavoidable losses.

In connection with such an investigation it is important that the steam generated per hour, the boiler efficiency, boiler losses, and steam costs be determined. An evaporative test or tests are usually conducted over the plant's running time, and often over a duration of a week or more to cover all phases of the operation. Besides the usual quantities of coal, ash, water fed, etc., steam quality is often quite important, as it affects steam engine and turbine efficiency. In the smaller industrial plant boilers this may lead to improving boiler water treatment, or to design of internal or external separators to furnish drier steam.

Evaporative Tests Aid in Getting Proper Fuel

These evaporative tests may furnish the information necessary to the selection of a more adaptable fuel, which in turn will lead to lower steam costs. It may be advisable to try two or more coals, tributary to the plant, and dictated by experience to be adaptable to the type of equipment installed and to the load characteristics. If the plant operates only during the daylight hours, the tests and data obtained may be divided into 8 or 10-hour operating periods, and the remaining hours of the 24-hour day into a non-operating period. However, if the plant operates continuously 24 hours a day, it should be set up on a 24-hour basis only.

When these operating data have been assembled, graphs can be drawn

Fig. 6. Two views of a small boiler room, showing effective use of simple hand-operated monorail for feeding coal to spreader stoker hopper. Left—Running monorail bucket into boiler room. Right—Bucket in position to load stoker hopper

to show the single and combined uses and distribution of steam. From such studies it can be determined if electrical generation of the power requirements can be economically carried out.

Selecting Fuel for Lowest Steam Cost

In the design of a plant, complete knowledge of the commercial fuels available to the plant is of utmost importance. In many plants, the first difficulty encountered has to do with the selection of a coal to fit the plant; whereas, the coal that can be successfully burned should be taken into consideration at the time plant is designed.

Analyses of the available coals are a guide as to the general characteristics of moisture, ash, volatile, fixed carbon, and sulfur. Heat value and ash fusion point are most important in determining allowable heat releases, combustion rates, and amount of water cooling for the furnace. Most important is experience in burning these coals in other plants over periods of operation that have established their commercial value and economy. With such experience as a background, the designer will not overlook any points in his design to meet full load and peak requirements, and to successfully burn the coals that are tributary to the plant so that efficiency and low maintenance will result.

Selection of Steam Generating Unit

It is common now to rate steam generating units in thousands of pounds per hour, rather than in horsepower, even for the smaller plants. The reason for this is due to the modern design of the units, which employs water walling in the furnace, and heat recovery in the form of superheaters, air preheaters, and economizers, making it quite impossible to apply the old definition of 10 sq ft of heating surface per bhp.

Therefore, when a plant's average requirements in thousands of pounds of steam per hour have been determined, as well as the pressure, temperature, or quality, with a further margin for probable growth of the plant within reasonable limits, specifications are issued, requesting bids on a steam generator of a continuous amount of steam per hour, capable of maximum peak demands of a few hours' duration.

There are so many types of generators to choose from that certain restrictions must be imposed to obtain competitive bids. These restrictions pertain to the types of fuel available to the plant, and their characteristics; space limitations; fuel burning equipment; available draft, if natural; coal and ash handling, which must be carefully selected and co-ordinated to obtain efficiency; ease of operation; and low maintenance.

Water Walls and Load Range

For instance, when a plant has a wide fluctuation of load, location and amount of water walling surface must be carefully selected, in order to obtain the highest efficiency over the whole range of loads. If too much black surface is exposed to the furnace in water walling, there may be danger of offsetting the good efficiency during the day load by a poor efficiency during the low night loads. Proper design and selection of the unit, with all factors considered, should produce an efficiency curve that is quite flat in appearance, with its peak at the average loading of the plant.

Considerable latitude must be afforded to the boiler designer, but in general the type of steam generator follows fairly well established patterns, and often the units as a whole, including fuel burning equipment, can be furnished by a single responsible bidder.

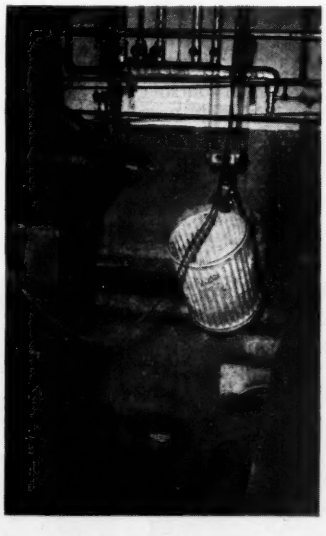


Fig. 7. Monorail also provides simple method of handling small amounts of ash from a small stoker in an ordinary ash bucket

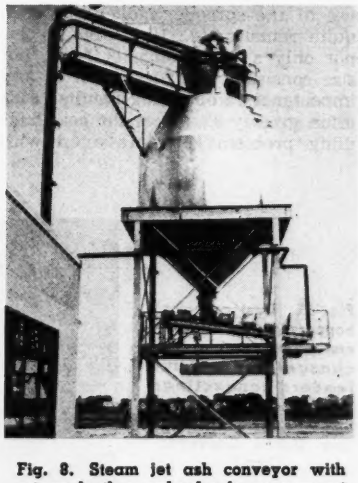


Fig. 8. Steam jet ash conveyor with rotary dustless unloader forms compact and effective ash disposal system for many small power plants. (Courtesy United Conveyor Corp.)

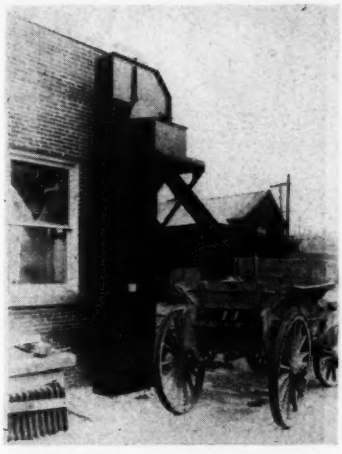


Fig. 9. Simple but effective ash handling—if the wind doesn't blow too hard

However, a further requisite can be stated in the specifications; that is, when separate bids are submitted covering boiler and fuel burning equipment, the bidders should coordinate their designs before offering them. In this way the plant designer may be assured of a complete unit to meet all the requirements and guarantees.

Selection of Fuel Burning Equipment

With a thorough analysis of the available coals, their characteristics and delivered costs, and the plant load demands, fuel burning equipment can be selected that will meet these demands most economically. This involves grate area, furnace design as to volume, water cooling, heat release, and heat recovery, as well as combustion rates of burning of the fuel.

Manufacturers of steam generating units and stoker manufacturers have always been conservative with regard to combustion rates. Having observed and conducted many boiler trials, it is our opinion that, in the new designs, these rates can be raised with safety. On forced blast chain grate stokers especially we find 200 per cent or better being carried on half the grate area installed, and on overthrow stokers rates up to 60 lb per sq ft per hour are possible with continuous ash discharge. Coal preparation has been improved, and more prepared coals are available, which makes it entirely feasible to specify increased combustion rates. This is important in the smaller plants, where often the light loads are of long duration, and will mean greater overall operating efficiency.

Among the more common types of fuel burning equipment available for the size of plant we are discussing are the single retort underfeed stoker,

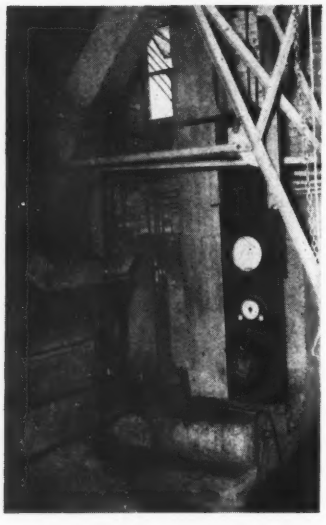


Fig. 10. Another small boiler room, showing simple but adequate boiler instrument panel

Fig. 5, the natural and forced blast chain grate stoker, and the spreader stoker, Figs. 6 and 14.

Chain Grate Stoker

Probably the simplest of these is the natural draft chain grate stoker, which, for steady continuous loads when burning the lower rank, noncoking bituminous coals, can produce very fair results on units rated from 15,000 to 25,000 lb of steam per hour. For straight heating loads, located in districts where the lower rank of bituminous coals has a natural market, it is most adaptable. It does not respond to sudden or variable loads, and below 15,000 lb per hour it has not proven satisfactory from several standpoints. Above 25,000 lb of steam per hour the forced blast type stoker is more adaptable.

The forced blast type of chain grate stoker has proven quite satisfactory on units rated between 25,000 and 50,000 lb of steam per hour, and can meet varying load demands with efficiency. Much advancement in the design and efficiency of this type of stoker has been made, with shortened arches and overfire air application.

Within the last few years there has been marketed as a complete unit a forced draft chain grate stoker for units under 25,000 lb of steam per hour. However, this stoker is mainly confined to straight heating and is seldom used in the type of plant under discussion.

Underfeed Stoker

One of the most common types of stoker for the smaller plants is the single retort underfeed stoker, usually of the unit type, the forced blast fan being integral with the unit or else separately mounted. This stoker will burn quite a variety of fuels, and is designed for moderate burning rates up to 35 lb per sq ft per hour. Its best range is between 10,000 and 15,000 lb of steam per hour, and under automatic control it will efficiently handle large fluctuations in load.

Spreader Stoker

The spreader type stoker is adaptable from 5,000 lb of steam per hour and above. The advent of the continuous ash discharge makes it adaptable to large units of 25,000 lb per hour and higher. The widest range of coals is possible with this type of fuel burning equipment. The design calls for a generous furnace volume, since much of the finer sizes of coal is burned in suspension; and often water walling, preheated air, and overfire air application. With this type of stoker, recognition must be given to fly ash collection and disposal, to eliminate the possibility of a nuisance from this source.

The rapid increase in the sale and use of the spreader stoker has been quite remarkable. It is able to use not only a wide range of fuels, but size consist of the fuel is not of any importance in obtaining results. This often greatly simplifies the coal handling problems encountered with other types of fuel burning equipment; and, with units that justify continuous ash removal, it has become competitive even with powdered fuel units in the larger plants. It is capable of taking wide fluctuations in load; can employ preheated air at high temperatures; and has a low maintenance. At light loads the efficiency of the spreader stoker decreases, while smoke emission increases; and it is not adaptable for economical banking, a condition which in small plants is often of long duration.

Heat Recovery — How Much Is Justified?

The advisability of additional heat recovery in the form of superheated steam, added surface or economizer, and preheated air recovery to the standard heating surface of the boiler depends on whether the added cost can be justified in savings. Seldom do pressures of steam generation in the smaller plants run over 200 lb per sq in., which limitation does not lend itself readily to additional expenditures for heat recovery. One simple form of heat recovery in these small steam generating units is in the form of a double unit wall suspension of the setting, and recovery of the unit's radiation. The additional cost for this type of construction is small, and can be fully justified. In addition to radiation recovery, the walls of the furnace, being air cooled, can often be substituted for water-walling. Temperatures of air for combustion as high as 175 F can be realized with this design. Recovery of between 2 and 3 per cent in the heat balance can be added in this way. Moreover, the setting will remain tight over the years, and linings can easily be replaced when this becomes necessary.

Combustion Control and Instrumentation

Of utmost importance is well designed and properly installed combustion control. In the simpler designs this consists of a master regulator, which controls the fuel-air ratio from the steam pressure. A separate overfire damper control maintains a predetermined overfire air pressure in the furnace, which is essential in maintaining good efficiency.

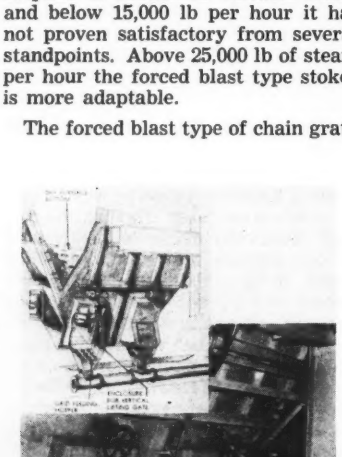


Fig. 11. Dry, gravity discharge ash pit hopper in a small plant. (Courtesy United Conveyor Corp.)

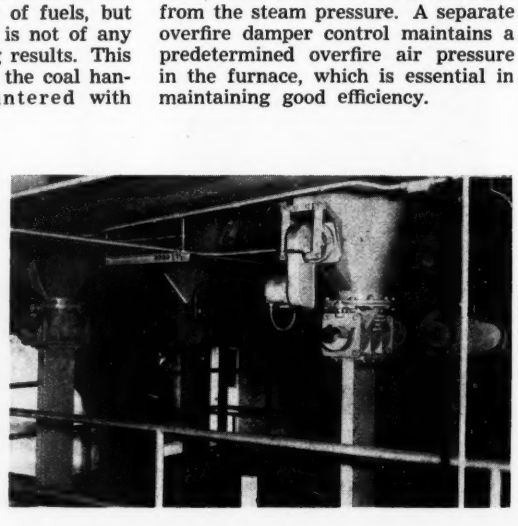


Fig. 12. Dust collector hoppers on small boilers, with vibrating dischargers and rotary feeders connecting through chutes to ash disposal system. (Courtesy United Conveyor Corp.)

Enough instruments should be installed to determine steam flow, flue temperature, drafts, feedwater temperature, and either a CO_2 recording meter or steam flow-air flow indicator. These should preferably be mounted on a suitable board, as in Figs. 2 and 10, and often the combustion control is mounted on the same board. Even in the smaller plants, control and instrumentation pay dividends.

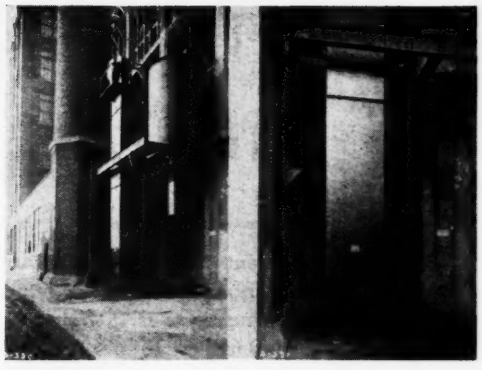


Fig. 13. Two views of a compact small plant coal and ash handling system

Feedwater Treatment

Feedwater treatment is becoming ever more important. Longer periods of boiler operation are possible with proper treatment, with longer life of boilers and lower maintenance costs. Whether this should be external treatment or internal treatment is a matter of study, but the trend is toward external treatment where deaeration of the feedwater can be effectively controlled, as well as chemical treatment. Blowdown losses are considerably lowered by external treatment, and external treatment affords opportunity for surge capacity, especially necessary where space heating is a large part of the load. It also affords ample hot water storage of treated water to take care of fluctuations in boiler load demands.

Coal and Ash Handling

Probably the most difficult problem in the smaller plants is that of fuel handling and ash disposal. Space is often lacking in older plants, and coal and ash handling is mostly done by hand labor. It is very difficult to show a return on the investment of coal and ash handling equipment when the coal consumption is five to ten tons a day. However, consumption of over ten tons per day necessitates storage, and where siding facilities exist, a reasonable amount can be expanded for coal handling. The coal silo, Fig. 1, has been found to be quite adaptable for this purpose, as it occupies but little ground space, and also affords means of weighing coal to the boiler unit.

The use of the mono-rail, Fig. 6, in handling coal for the smaller plants has been found to have many applications, and can also be combined with ash handling, Fig. 7. For lifting the loads, a motor can be applied, and, if properly designed and operated, the travel can be by hand. Scales with beam can be interposed on a convenient wall, and the whole arrangement is quite economical.

Ash disposal by the more recently designed steam jet evacuation system, Fig. 8, is clean and economical, and disposition can be made to dustless overhead tanks for disposal. Fly ash is usually re-injected, but when its value is too low for this purpose, it can be disposed of by the ash disposal system.

Electrical Generation

Having determined the advisability of electrical generation, the type of equipment must then be selected. Where large quantities of exhaust steam are called for, often at different pressures, the bleeder turbine lends itself most admirably for such extraction. Unfortunately, however, bleeder turbines below 500 kw are not standard design; but at least two bleeding pressures can be obtained above this size. If the low pressure requirements are sufficient to use the remaining exhaust, the machine can be non-condensing and supply 5 lb low pressure service. If condensing water is available, and can be used in the plant process work, as in paper mills, most of the heat going to the turbine can be thus recovered.

The uniflow engine is a most useful machine for the smaller plants, and can produce current economically, using up to 200 lb per sq in. and 100F superheat, and can exhaust up to 10 lb back pressure. The selection of pressure and temperature should be governed by the relation of electrical load to process steam demand, and a balance worked out to co-ordinate the two to avoid losses to the atmosphere. Often two sizes of engine and generators are installed, not only to afford a spare unit, but to meet seasonable demands, such as the heating load in the winter months. Power factor correction in the smaller plants is necessary, in order to make full use of the generating capacity and hold size of units to a minimum.

Purchased Power

When Public Service power is available, a certain amount of throw-over service may be desirable and economical. This often occurs in the non-heating months when a portion of the power can be purchased economically to make an over-the-year economy. In plants where refrigeration in the summer months is heavy, as in small packing plants, Public Service companies have been found to co-operate in providing part throw-over service during these periods.

It is not necessary that this service be synchronized with the plant. More often a definite section of the load is thrown over onto the Public Service.

Records

The engineer of the plant should keep a record of his operation, and simple record sheets can be devised to show the daily and up-to-date performances of the plant each month. The record should show daily efficiencies of the steam generating unit; coal cost of steam, usually in units of 1000 lb of steam generated; distribution to the various departments; and cost of current based on steam to electrical generating units, with due credit to exhaust or bled steam for process work.

In this way daily checks can be made of the performance, undue losses can be corrected, and the highest efficiency at all times can be obtained.

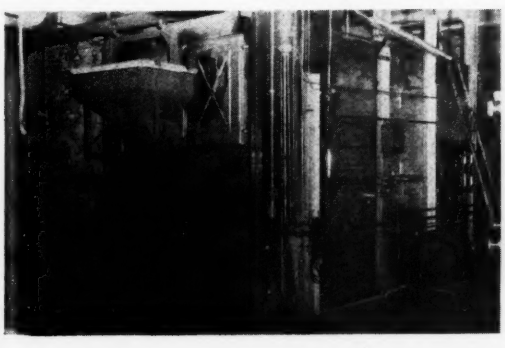


Fig. 14. General view of same unit shown in Fig. 6, showing mono-rail, boiler setting details, blower

METAL-CLAD SWITCHGEAR INSTALLATION HINTS

Shipment of interconnected units eliminated much field work . . . Method of installing floor sills . . . Lifting and shipping members . . . Care necessary in removing units from freight cars . . . Inspection of oil circuit breakers . . . Testing insulating oils . . . Installation of blast type circuit breakers . . . Applying insulating tapes . . . Selecting correct insulating compounds . . . Precautions to be observed in making silver-to-silver joints; proper pressures for such joints . . . Instruments and relays . . . Secondary wiring . . . Protection of switchgear finishes; cleaning and refinishing damaged surfaces . . . Grounding

By J. P. Murray

Switchgear Division, General Electric Company, Philadelphia, Pa.

ONE of the most important aims of switchgear manufacturers today is to produce equipment that is easy to install. This has been accomplished by metal-enclosed switchgear which utilizes a self-supporting steel structure with a complement of devices arranged for safe operation by experienced as well as less experienced operators.

To eliminate as much field work as possible during the installation of metal-enclosed equipment, a number of interconnected switchgear units are placed on a single shipping skid. These skids are called shipping sections. The number of units that can be placed on a skid depends entirely on the carrier and the customer's handling facilities and, at times, on the opening into the room where the switchgear is to be installed. When the shipping sections are long and include a number of units, the time required for installation work is greatly reduced. It is not unusual to separate a 25-unit switchgear equipment into four or five shipping sections. Since the shipping sections are completely assembled and wired and ready for the installation of the incoming cables, little time is necessary to place the switchgear in service. Such complete assemblies also place on the manufacturer a greater responsibility for the proper coordination of the devices included as a part of the equipment.

In the following are some of the most important items to be considered during installation. They are not, however, intended to be a complete coverage of the subject, and manufacturer's instruction books should always be consulted.

Switchgear Floor Sills

The steel floor sills to which the equipment is permanently secured should be installed in accordance with the manufacturer's recommendations. The sill members should be straight and free from twists; they should be installed so that the top surface is clear of the finished concrete floor before the equipment is bolted or tack welded to the top of these members. This operation, often neglected, should have competent supervision for, if care is not taken at this time, the switchgear may not be level and its general appearance will be greatly affected. After these steel members are in place, steel shims, if necessary,

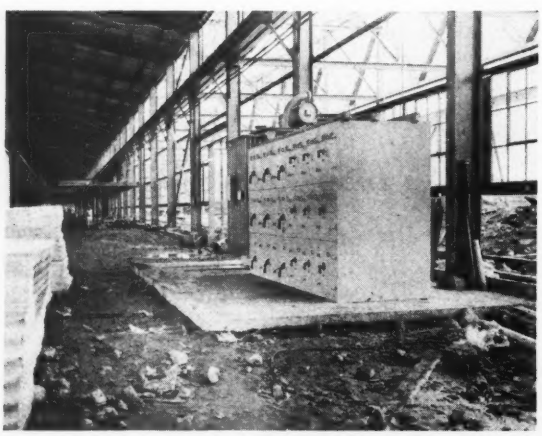


Fig. 1. Switchgear installed and ready for service before factory building is completed

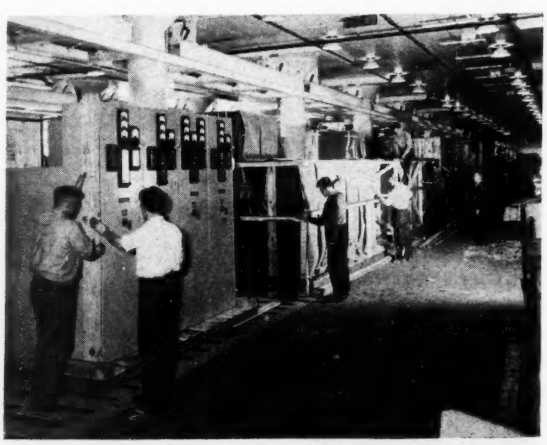


Fig. 2. Switchgear shipping sections in the process of being packed for shipment

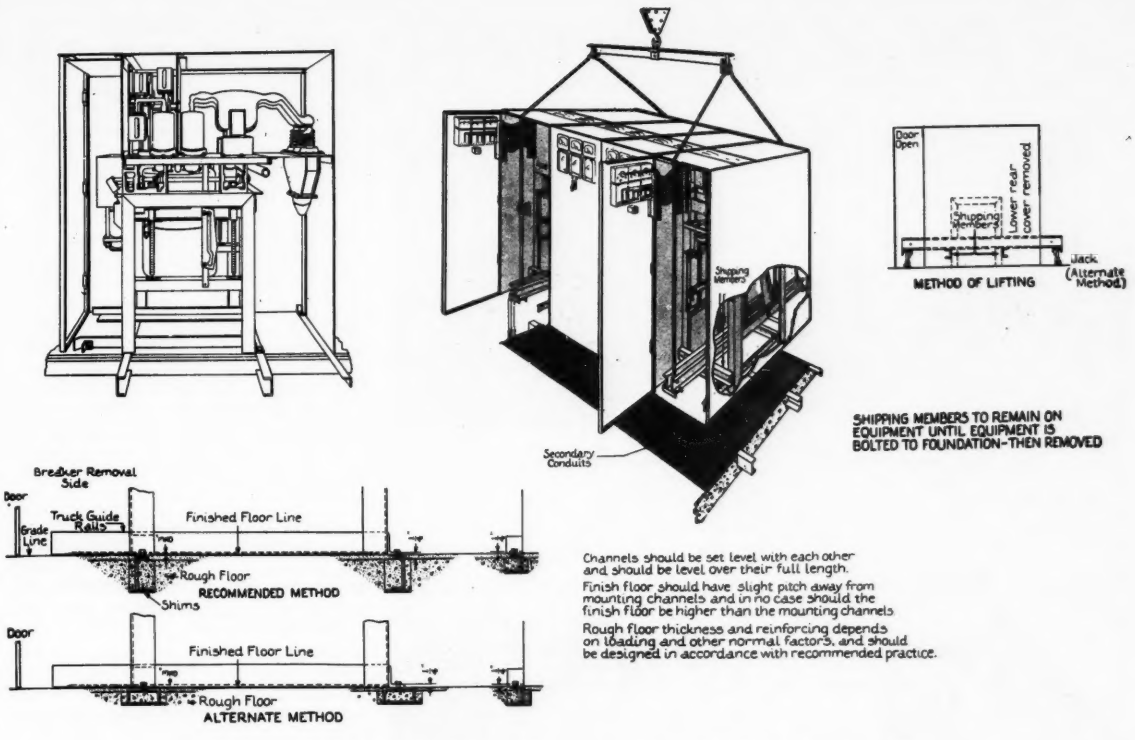

Door Open
Lower rear cover removed
Shipping Members
Jack (Alternate Method)
METHOD OF LIFTING
Shipping Members
Secondary Conduits
SHIPPING MEMBERS TO REMAIN ON EQUIPMENT UNTIL EQUIPMENT IS BOLTED TO FOUNDATION-THEN REMOVED
Breaker Removal Side
Door
Truck Guide Rails
Grade Line
Finished Floor Line
Rough Floor
RECOMMENDED METHOD
Shims
Door
Finished Floor Line
Rough Floor
ALTERNATE METHOD
Channels should be set level with each other and should be level over their full length.
Finish floor should have slight pitch away from mounting channels and in no case should the finish floor be higher than the mounting channels.
Rough floor thickness and reinforcing depends on loading and other normal factors, and should be designed in accordance with recommended practice.

Fig. 3. Methods of handling modern switchgear and the installation of steel floor sills

should be used to level the sills and the top surface closely checked with a surveyor's instrument before they are grouted in, then rechecked before that section of the cement floor hardens. This work should be done before the remaining section of the rough flooring is completed. When undertaking this work it should be remembered that a single unit of modern switchgear is about 2 to 3 ft wide and sometimes weighs between one and two tons. Therefore, the floor strength should be checked for the loading of the switchgear.

Lifting and Shipping Members

Metal-clad switchgear is fabricated from sheet-steel members and structural shapes, and the manufacturer is very careful to have all units square and level. Care should be taken in removing the equipment from freight cars and in handling during installation to preserve this alignment. If parts of these units should become distorted due to unusually rough treatment during transportation, they can be readjusted to put them in good condition.

Lifting and shipping members are provided by the manufacturer so that the equipment can be more easily handled during the installation period. After the switchgear has been removed to its approximate location, the lifting channels can be utilized for elevating the equipment by a motor-operated crane or jack screws. The shipping skid can then be removed and the equipment lowered to the floor sills. When additional movement of the switchgear is necessary, the pressure should be applied to the shipping channels which run the entire length of the equipment. Additional switchgear units can then be placed on the floor sills as near as possible to the preceding section. When all sections are in line on the floor sills and openings appear between the various sections either at the top or bottom, it indicates that the floor steel is not level, or the floor has sagged due to the weight of the equipment. In any event it will show where and how the steel shims are to be placed under the equipment sections so that the completed switchgear will be level and present a pleasing appearance.

Oil Circuit Breakers

Oil circuit breakers and their operating mechanism should undergo a rigid examination before they are placed in service. This is necessary due to possible rough handling during transportation. The breaker oil tank should always be removed so that the wood operating rods, contacts, and other moving parts can be inspected, and also to ascertain if all bolts, nuts, and cotter pins are in place and properly secured. The solenoid mechanism should be checked for parts that may have worked loose during transit. A sample of the insulating oil should be tested at 25-kv in a standard gap with its points set at 0.1 in. If the oil breaks down during test it should be refiltered as many times as is necessary until this value is reached.

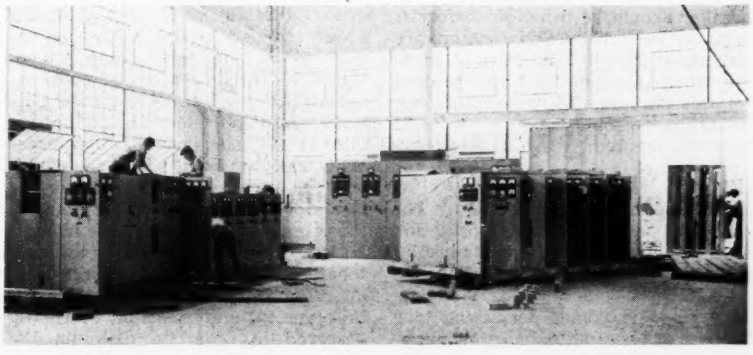


Fig. 4. Moving modern switchgear shipping sections into factory building

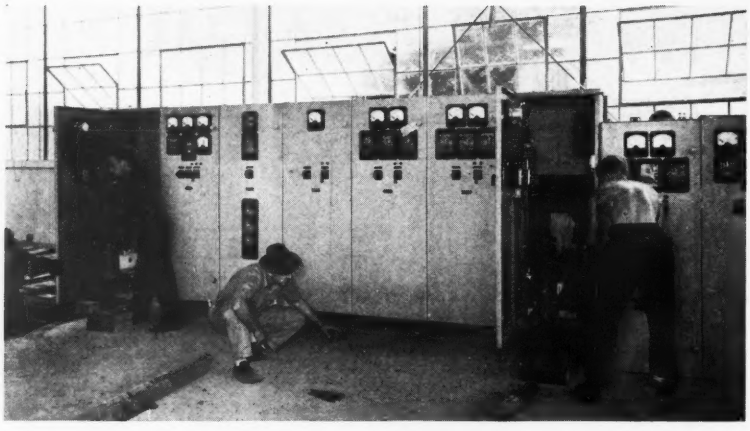


Fig. 5. Switchgear elevated on screw jacks to remove shipping skids

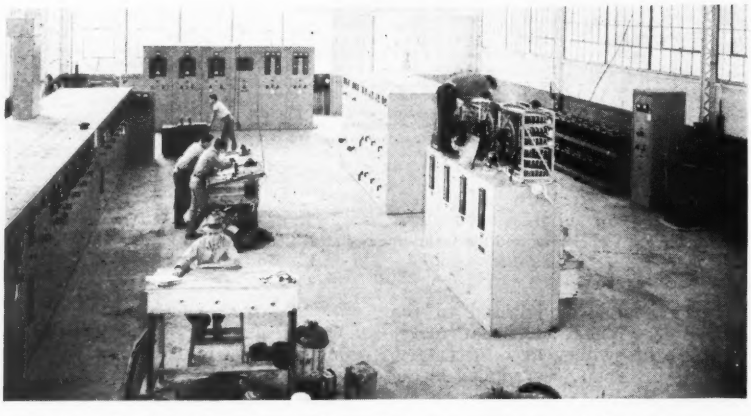


Fig. 6. Modern switchgear completely installed, equipment being checked and tested

Blast Type Circuit Breakers

Blast-type breakers and their operating mechanism should be given the same rigid examination and inspection that is required for oil breakers. The box barrier should be removed so that the contacts and arc chutes can be checked for moisture and to see that no parts have been broken during transit. The insulated parts and contacts must be clean and dry, and all operating parts of solenoid and breaker should operate freely. If moisture is found inside the breaker or on the surface of the arc chute, the breaker should be dried out before it is placed in service. Strip heaters are sometimes installed in units of modern switchgear, and they may be used for this purpose. All bolts, nuts, and cotter pins should be inspected and properly secured.

Insulating Tape

Modern metal-clad switchgear has been designed with high insulation levels. Since the quality of the insulation must be maintained after the equipment is placed in service, the proper application of insulating tape to bare copper parts helps to maintain this value. Precautions must be taken to prevent the operating voltage from creeping over the surface or puncturing the taped joint. These requirements are met in a well-taped joint by overlapping the layers, so as to provide adequate creepage distance, and by building up the thickness by uniform layers free of air pockets, until sufficient puncture strength is obtained. Insulation previously installed should be tapered towards the bare copper conductor, and the new insulating tape applied in overlapping turns should start from the top of the taper. The length of this cut-back or taper and the thickness of the tape to be applied should be determined by the degree of insulation on the parts being joined. When a three-conductor cable is opened for its installation to a pothead, additional tape should be applied to the independent cables, especially near the point where the cables start to separate. When supporting insulators are involved similar to those used with potheads, the insulating tape should be extended to cover the first ring of the porcelain insulator. The method of application for this tape insulation should be rigidly observed in order to maintain the high standards of insulation set up by the manufacturer.

Insulating Compounds

When asphalt compounds are selected for insulating purposes, extreme caution should be taken in selecting the correct material for a specific application. A pothead compound with a pouring temperature around 120 C will not always be the correct material, for if the connecting cable has an oiled paper insulation and has a considerable amount of head over the pothead location, the insulating oil in the cable may liquefy the compound. Under this condition, an oil-resisting compound should be selected. When this material is used to insulate bus or connection splices that have been located in a steel enclosure, the compound selected should have a high pouring temperature. One around 200 C in most cases has proved satisfactory when the enclosures are properly ventilated.

Silver-To-Silver Connection Joints

Copper joints for primary connections are silver-plated. Silver-surfaced areas may become discolored if they are exposed to atmospheric gases for a considerable length of time. This discoloration, should it exist on joints which must be made during the installation, can best be removed without harm to the silver surface by polishing with a clean cloth saturated with carbon tetrachloride or by using a good grade of silver polish. It should not be removed with rough cleaning materials such as sand paper, steel wool, etc. Draw-filing or attempts to obtain smooth-appearing surfaces will not necessarily improve the efficiency of the contact.

To produce a proper contact pressure on silver-to-silver surfaces not more than 20 ft-lb need be exerted in tightening a ½ in. or ⅝ in. diameter bolt. This is suggested to prevent the copper from being distorted due to bus expansion should the copper become heated, and to eliminate the possibility of the fastening bolts becoming stretched, or the distortion of the line contact plates.

Instruments and Relays

Instruments, relays, and secondary control devices are shipped, assembled, on modern switchgear. Since they are subject to some vibration during transportation they should be carefully inspected before they are placed in service. Shipping stops or blocking should be removed, and when it is necessary, the pointers of indicating instruments should be reset at zero. The rotating discs of all induction relays should be revolved to ascertain if there is any binding between the rotating and stationary elements. All devices should be properly calibrated according to instruction books furnished by the manufacturer.

Secondary Wiring

During the installation period contact nuts and screws, used to secure secondary wires to device studs, terminal blocks, etc., should be inspected to ascertain if these parts are tight and the wires are secure before the

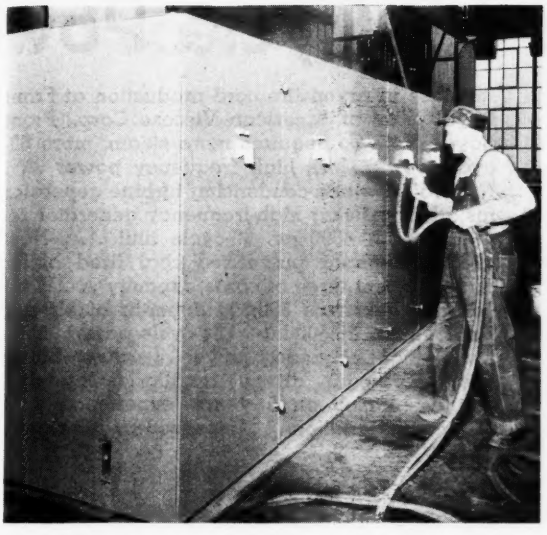


Fig. 7. Colored lacquer applied with air gun to modern switchgear

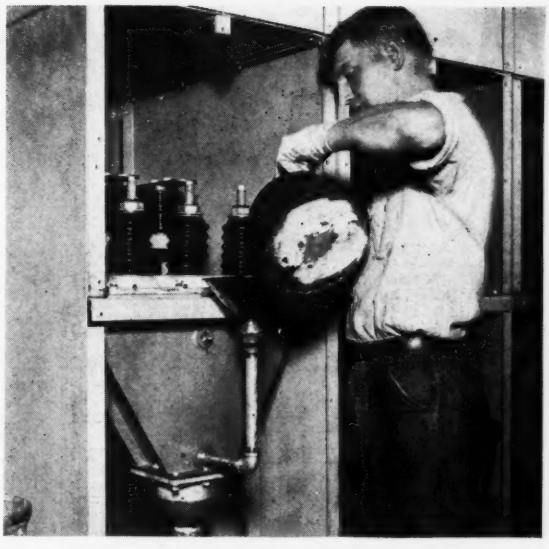


Fig. 8. Pouring insulating compound around the cable division of an entrance pothead

equipment is placed in service. When it is necessary to make wire connections during installation, they should be secured to terminals with crimped washers or solderless terminals. Solder-type terminals should be avoided as much as possible since acid or soldering flux may consume the end of the wire and cause an open circuit. Although secondary wiring is checked or tested at the point of manufacture, the user should have his station operator or maintenance personnel check the physical wiring against the drawings furnished with the switchgear. In that way the station operator or maintenance personnel, who will eventually live with the equipment, will become familiar with the lay-out of connections.

Switchgear Finishes

Several coats of primer and various colored lacquers are applied to both the inside and outside of the switchgear. The interior is usually finished with a light colored lacquer so that the more important tripping and safety devices will stand out against this background. The exterior should be finished with a color that will not show general station dust settlings, gray having been found the most acceptable. The exterior should be covered with heavy paper or canvas to protect the finish during the erecting period. When the finish has been disfigured slightly with finger marks or any foreign substance, it can best be removed with a clean cloth saturated in carbon tetrachloride, cleaning a small section at a time. It is sometimes quite difficult during the erection of station equipment to fully protect the finish of switchgear. If the surface has been scratched to any extent the entire front of the equipment should be refinished after all construction work has been completed. Several applications of a surface filler should be applied on sections where deep scratches appear on the finished surface. When the damaged surface has been sanded to the original smooth finish, all devices assembled on the switchgear should be entirely covered with a masking tape and two coats of lacquer of the desired color applied by air pressure. This should restore the finish to its original state.

Switchgear Grounding

Metal-enclosed switchgear is equipped with a rectangular, copper-ground bus, which should be connected to the station ground, independent of any grounds for machine or apparatus neutrals. This ground bus, which is bolted to the steel structural units, provides facilities for the completion of a metallic connection to the station-ground bus at the point of installation. The ground bus furnishes a means of maintaining the switchgear at or near ground potential, thereby providing safety to operating personnel. In addition, it provides a connection to ground for certain protective and operating devices. Steps should be taken to maintain good connections in the ground circuit at all times. Consequently the connections at the ground bus, frames, and outgoing leads should be properly made and maintained.

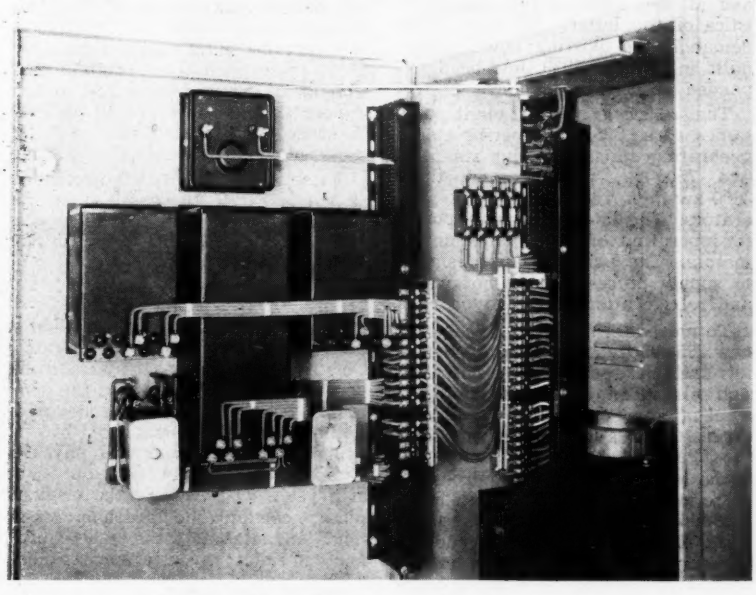


Fig. 9. Secondary wiring as applied to a swinging panel

More Steam and 60-Cycle Power

Increase in rayon tire cord production at Front Royal plant of American Viscose Corp., Front Royal, Va. . . . Requires more steam, more 60-cycle power, less high frequency power . . . New 7500-kw non-condensing turbine generator installed, existing high-frequency generator replaced with 4000-kw, 60-cycle unit . . . New 225,000 lb-per-hr pulverized coal fired boiler added to first three of same capacity . . . Plant can now generate 900,000 lb-per-hr of 410-psi, 700 F steam, 26,500-kw of 60-cycle power, 6000-kw of high frequency power . . . New boiler has all steam driven auxiliaries; several changes based on 5 years' experience with original installation . . . Improved heat balance

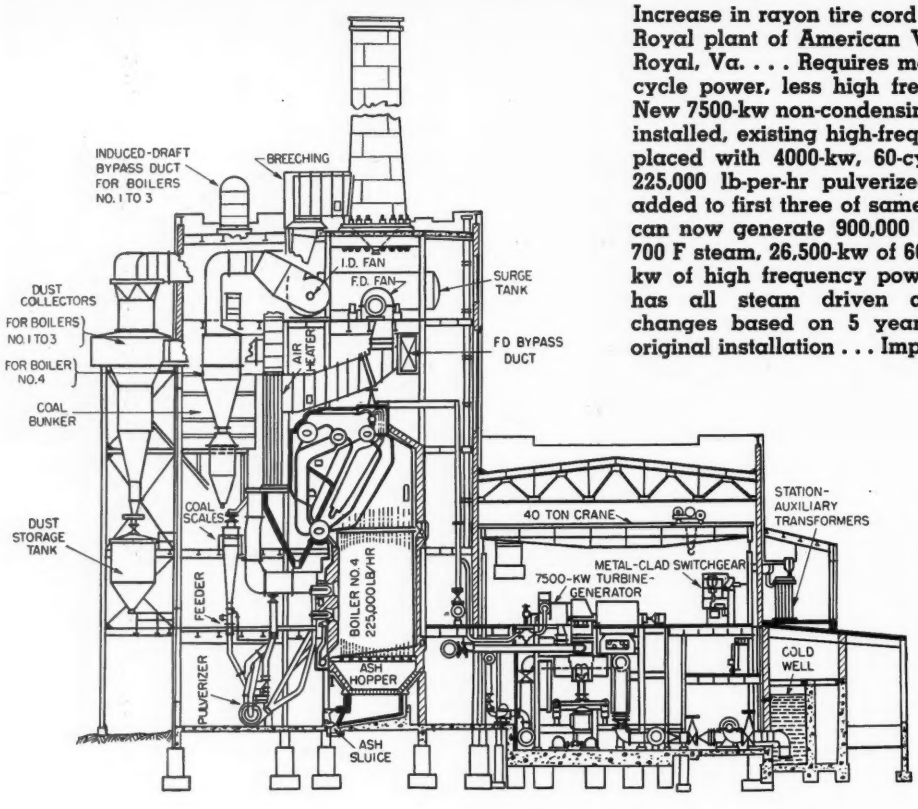


Fig. 1. Cross-section through Front Royal power plant. New boiler No. 4 same general design as first three, but some differences in details, auxiliary drive, dust collector arrangement

RECENT EXPANSION of facilities for production of rayon tire cord at the Front Royal plant of American Viscose Corp. at Front Royal has increased the process steam and electric power demands and altered some of the characteristics of the latter. To meet these demands, the existing power plant, built in 1938 to 1939, has been expanded as described below.

The existing power plant contained three 225,000 lb-per-hr steam generating units, supplying steam to two 7500-kw, 60-cycle and three 3000-kw high-frequency turbine generators. The latter furnished power for operation of 7000-rpm spinning motors. The plant also is designed to supply process steam, hot water and refrigeration to the rayon mill.

To meet the increased demands, a new 225,000 lb-per-hr steam generating unit has recently been installed and placed in operation, giving a total of four such units. Because of recent changes in spinning machines for tire cord production, more 60-cycle power is now required for these new machines and less high-frequency power. Accordingly, a third 7500-kw, 60-cycle, non-condensing turbine generator has been installed and one of the existing high-frequency units is being equipped with a new 4000-kw, 60-cycle generator.

As the plant now stands, therefore, it has a total generating capacity of: 900,000 lb of 410-psi 700-F steam an hour; 26,500-kw of 60-cycle electric power; and 6000-kw of high-frequency power. Added to that is a refrigeration plant of approximately 3000-tons capacity, the original section of which was described in the June 1943 issue of POWER PLANT ENGINEERING.* All four boilers will be required to carry the load in winter.

These elements are connected as shown in Fig. 5 to supply steam at various pressures, electric power, hot water, refrigeration and other service to the mill.

Details of Original Plant

The power plant was originally designed in 1937 (and first operated Oct. 1939) with provisions for future necessary expansion. Hence the general characteristics of the added new units were more or less fixed by existing steam conditions and physical arrangements. However, on the basis of 5 years' operation of the original plant, certain modifications were made in details of the new equipment to reflect the experience gained. The following discussion will be confined largely to the differences in the new and the existing equipment. To understand them clearly, it is necessary to look over the existing plant in a little more detail.

*Refrigerating System at Front Royal, Power Plant Engineering, June, 1943.

Three Original Boilers

The initial 1939 installation consisted of three Combustion Engineering Co. vertical, bent-tube, 4-drum boilers, each of 225,000 lb-per-hr peak capacity (200,000 lb continuous). These generated steam at 410-psi, 700-F for 5 General Electric turbine-generators originally installed, as shown in Figs. 5 and 8.

Each of the three original boilers is fired with pulverized coal supplied by two 5-ton-per-hr Raymond mills per boiler. They were equipped with Elesco intertube super-heaters, CE Co. tubular air preheaters, American Blower forced and induced draft fans, two of which are motor-driven by GE motors through American Blower hydraulic couplings, and one unit with GE geared turbine and an American Blower flue dust and soot eliminating system. Diamond soot blowers and Bailey automatic combustion control were also provided on these boilers. Allen-Sherman-Hoff ash hoppers and sluicing system are installed.

for Front Royal

By
Theodore Maynz
Power Supervisor
American Viscose Corp.

As told to
CHESTER R. EARLE
Associate Editor, Power Plant Engineering

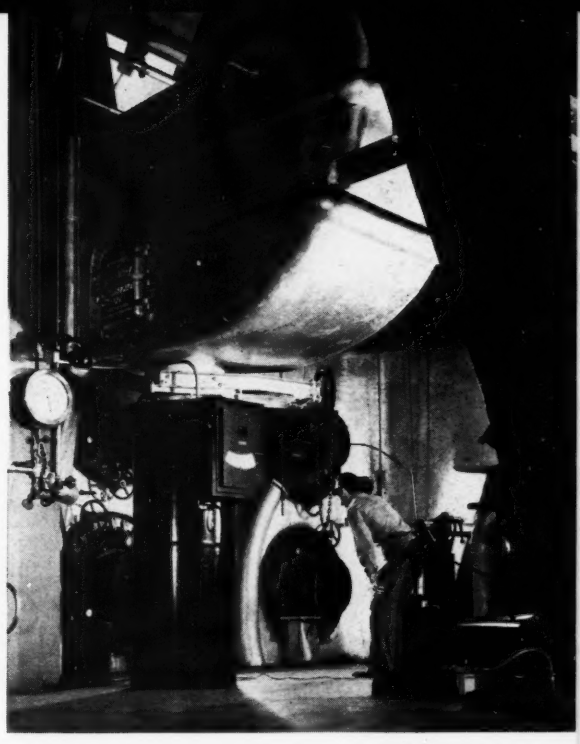


Fig. 2. View on boiler operating floor at Front Royal, showing pulverizer feeder, burners, preheated air and mill tempering air ducts, operator checking combustion

Feedwater make-up was supplied by a Foster-Wheeler 3-stage evaporator, Fig. 5, heated in two Cochrane deaerating heaters and an Alco closed heater and pumped to the boilers by four Ingersoll-Rand 500-gpm centrifugal boiler feed pumps, three driven by Terry turbines, one by a 3600-rpm motor. Copes feedwater regulators control boiler water levels.

Original Turbine Generators

Two of the original 5 turbine generator units are 7500-kw condensing extraction machines, from which steam is extracted at 25-psi for process and feed heating and evaporators. Each of these units drives a 3-phase, 60-cycle, 6900-v, 0.8-pf generator at 3600-rpm. The other three machines are known as the high frequency units, each consisting of a GE 3000-kw condensing extraction unit driving a 3-phase, 0.8-pf 6-pole generator at any speed from 2400 to 3600-rpm. At the three usual speeds, the generators produced 120-, 150- or 180-cycle power at voltages of 2760, 3450, and 4140 respectively. These machines have turbine governors in which the springs need not be changed to alter the speed. A general view of these units is shown in Fig. 8.

The turbine condensers are C. H. Wheeler Mfg. Co. units, two of 13,300 sq ft each for the 7500-kw machines and three of 5700 sq ft each for the 3000-kw machines.

A spray pond with "Spraco" nozzles cools condenser circulating water and process water. Three Wheeler 20,000-gpm circulating pumps are installed together with four 75,000 lb-per-hr and six 35,000 lb-per-hr Wheeler condensate pumps, all motor driven.

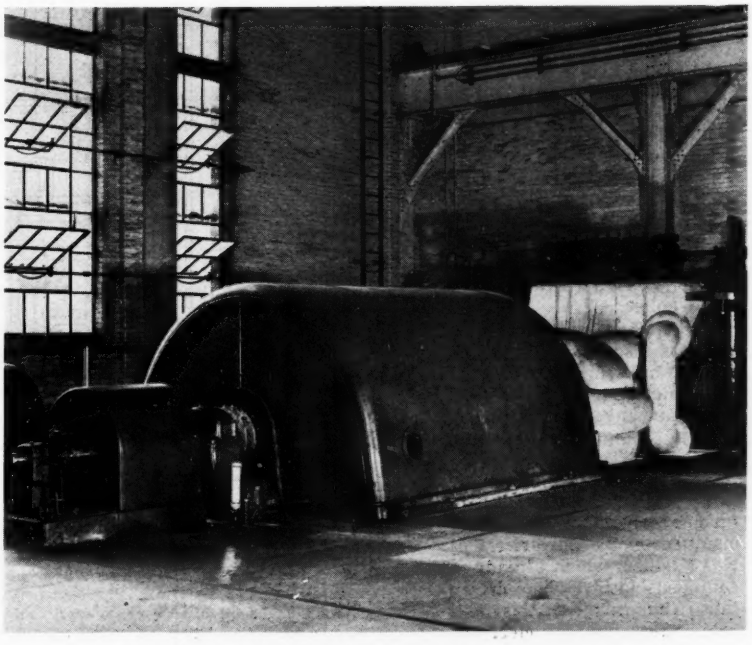


Fig. 3. View of the new 7500-kw 60-cycle turbine-generator

Evaporators Supply Process Steam and Feedwater

The original design of the plant included the triple-effect evaporator as shown, to which the boilers supply sufficient 410-psi steam to produce 25-psi process steam from the 3d effect. This was done because, during four winter months, not enough 25-psi steam could be extracted from the main turbines to meet all demands, hence about 80,000 lb of steam an hour would have to be supplied through a reducing valve to the 25-psi line. Use of the evaporator prevents this.

This 25-psi supply is now augmented by the exhaust from the new main unit, new steam-driven boiler auxiliaries and new steam-driven refrigeration compressors as described, as well as by an additonal 8-in. line with a Hagan pressure-reducing valve and desuperheater in the mill.

Details of New Boiler Units

New boiler No. 4 is a Combustion Engineering Co. four-drum bent-tube unit of the same general design as the original units. The particular unit installed was originally fabricated for another plant but was cancelled for that project under the WPB restrictions and allotted to Front Royal. It was designed for 600-psi drum pressure.

This No. 4 boiler has 12,775 sq ft of heating surface and furnace volume of 12,000 cu ft. The furnace is designed for heat release of 21,500 Btu per cu ft per hr at 225,000 lb-per-hr steaming rate.

Like the three original units, it is fired with pulverized coal supplied

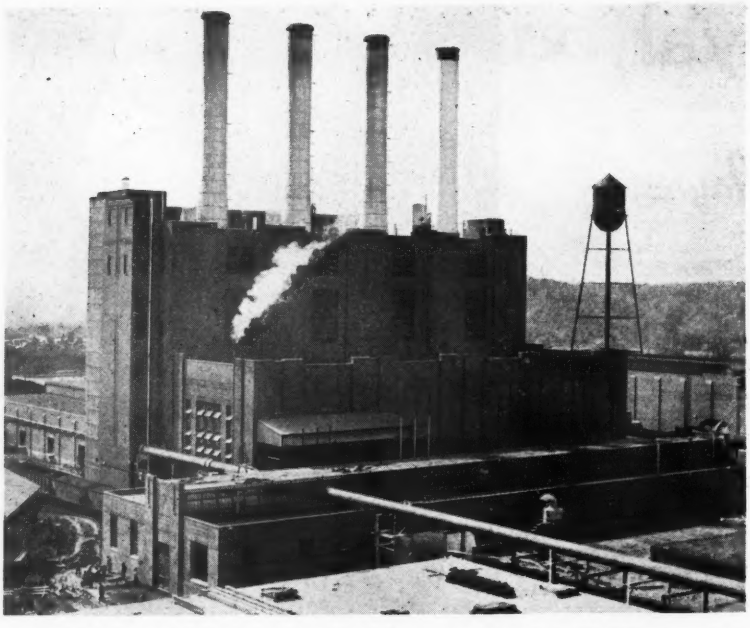


Fig. 4. Front Royal power plant: stack for new boiler No. 4 at right end

by two 10½-ton-per-hr Raymond bowl mills. Four pulverized coal burners are installed.

The new boiler is equipped, like the original units, with Elesco superheater, CE tubular air preheater of 25,700 sq ft, Diamond soot blowers and Copes feedwater regulators.

New Boiler Differs in Some Details

The new boiler differs from the original units in several important details. First, instead of an intertube superheater, the new unit is equipped with an interdeck superheater between the first two banks of boiler tubes. The engineers believe that the superheater in this location will give a better steam temperature curve and will be easier to clean and maintain than in the intertube location. It is also equipped with an improved slag screen.

Another difference between Boiler No. 4 and the first three units is that on unit No. 4 some changes have been made in the air preheater ductwork. On each of the original boiler units, a bypass interconnection duct was provided, so that any ID or FD fan could be used on any boiler.

However, this bypass duct has been used only once. With sequence control it is difficult to take care of cutting out the control in an emergency. Hence it did not seem worth while from the operating point of view and it was omitted on the No. 4 boiler. Its omission also eliminates a dust nuisance, for the duct gradually collects flue dust, which can be removed only by periodical hand lancing with an air jet to force it out the stack.

Finally, on the No. 4 boiler, a Western Precipitation Corp. dust collector is installed, and, as shown in Fig. 1, this is placed inside the building instead of outside as in the three original units. The elimination of the air-preheater bypass connections and minor rearrangements of other equipment provided space inside the building for the collector.

The stack for the new unit is of steel, and like the other three, is lined with Vitribestos.

New Boiler Has All Steam-Driven Auxiliaries

For the No. 4 boiler, complete geared, steam-turbine drive of all auxiliaries except for the coal feeders, has been adopted, to make the unit independent of electrical connections and at the same time to improve the control of the auxiliaries at low load.

Forced and induced draft is supplied by American Blower Co. fans. The forced draft fan has a capacity of 65,000-cfm and is driven by a General Electric Co. 150-hp geared steam turbine. The induced draft fan has a capacity of 135,000-cfm and is driven by a General Electric Co. 300-hp geared steam turbine. These fan drives are duplicates of the fan drives on the original No. 3 boiler.

Each pulverizer on the new boiler is also driven by a GE Co. 150-hp geared steam turbine, and the new boiler feed pump, an Ingersoll Rand Co. unit of 500-gpm capacity is driven by a Terry Turbine Co. 250-hp steam turbine, similar to the original pumps. Steam turbine drives are also to be installed on the pulverizers of No. 3 boiler, which already is equipped with turbine-driven fans, thus making this unit also independent of electrical connections.

Mill Load Control

Each of the steam turbine drives on the two pulverizers of No. 4 boiler is equipped with an interesting double pressure Mercoid relay. One pressure switch with its relay operates so that if the mill is overloaded, thus causing the pressure to rise in the turbine nozzle casing, this pressure rise operates the relay to cut out the coal feeder motor. When the mill is clear again, the feeder starts automatically. The other relay is a minimum pressure relay. If the pressure in the turbine nozzle casing is too low to operate the mill at full speed, this relay prevents the feeder motor from being started.

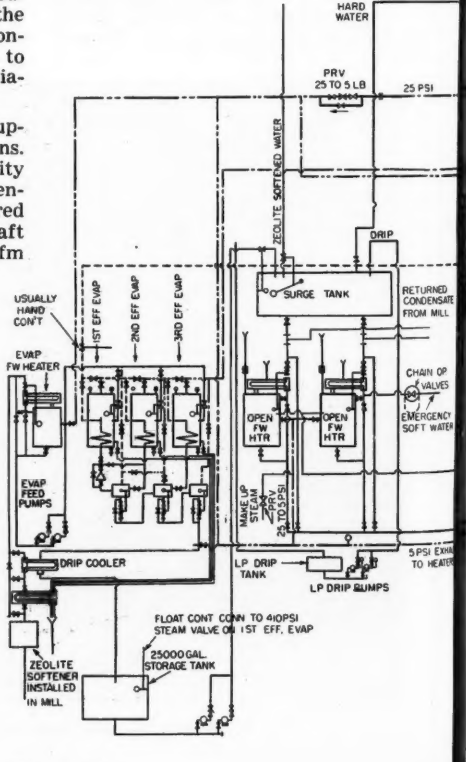
Each boiler now has a remote controlled induced draft damper to improve operation at low load.

In the original boilers, not enough tube dusting doors were provided, so in the new No. 4 boiler 12 additional doors are installed.

Changes in Existing Boilers

Existing boilers, Nos. 1, 2 and 3, although their operation has on the whole been very satisfactory, never gave the flue gas temperatures expected of them. Explorations of the settings were made with gas analyzers and temperature measuring devices.

Finally it was found that the combustion gases were short circuiting at the sides of the superheaters. This was caused by the shape of the risers from the upper header of the side water walls, which, being inside the brick setting, interfered with the front and second tube bank end tubes adjacent to the wall.



To overcome this difficulty, the boiler manufacturers have provided, without charge, specially bent tubes for the first tube banks of these boilers, three tubes for each side of each boiler, to close up that side passage and prevent the short-circuiting of the combustion gases.

Some trouble was encountered also with the ground joints on the superheaters of the first three boilers. Consequently No. 4 boiler superheater is provided with seal-welded ball joints.

In installing the new boiler and turbine, more welding has been used on the steam lines than in the first units. Main valves are stellited and are made with one end flanged and one end welded. The flanged ends of the valves were used against existing flanges originally installed on the main steam header.

A number of other details in the old boiler units and their auxiliaries, as well as in other items of the plant, have been improved since the plant went into operation. Some of these changes are described below.

Fig. 6. Boiler operator Charles E. Sensabaugh taking readings at boiler control panel

Changes in Auxiliary Exhaust

Some changes in the auxiliary exhaust conditions were deemed advisable to improve low load operation. The boiler feed pump turbines in the original installation exhausted to the 5-psi header to supply steam for feedwater heating in the closed heater. At low load these turbines provided all the feed heating steam required, hence the 5-psi exhaust from the forced and induced draft fan turbines had to be exhausted to atmosphere under these conditions. However, as shown on Fig. 5, the fan turbines have been rearranged to exhaust to the 25-psi header. Thus, when there is an excess of auxiliary turbine exhaust steam, it can pass directly to the 25-psi mill supply line and is not wasted to atmosphere.

Expansion of Coal Handling System

Additional coal-handling facilities are being installed. Another set of railroad tracks and loading hopper are being provided and installation of a feeder for stocking coal is included. At present, all coal comes to the plant by rail, is discharged through a magnetic separator and a crusher and is transported by a skip hoist to a receiving hopper in the top of the boiler house. Thence it is conveyed by a flight conveyor to the raw-coal bunkers at each boiler. This flight conveyor is enclosed in a dust-proof housing.

Previously, in operating this flight conveyor, chain rollers jumped off the rail when operator inadvertently operated the conveyor with the bunkers completely filled, thereby wrecking the conveyor. To prevent this, we have installed, at the entrance of each coal pocket, a spring-mounted

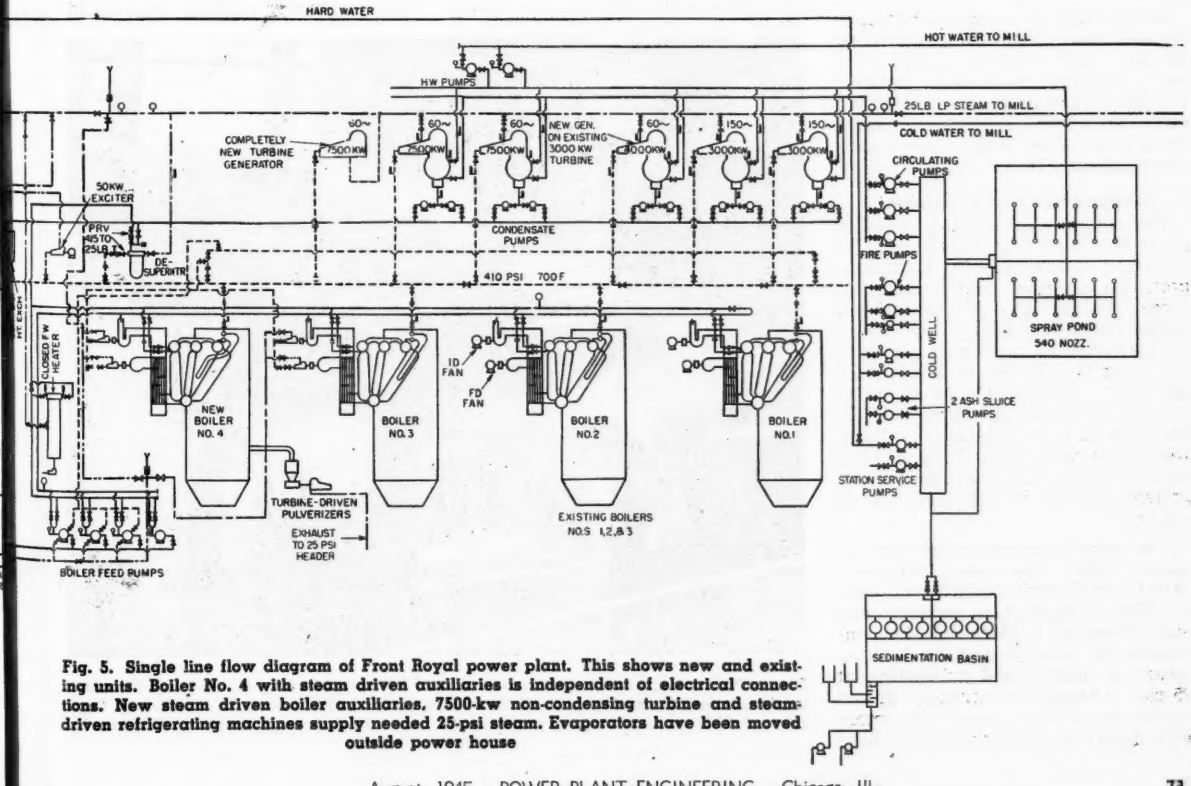


Fig. 5. Single line flow diagram of Front Royal power plant. This shows new and existing units. Boiler No. 4 with steam driven auxiliaries is independent of electrical connections. New steam driven boiler auxiliaries, 7500-kw non-condensing turbine and steam-driven refrigerating machines supply needed 25-psi steam. Evaporators have been moved outside power house

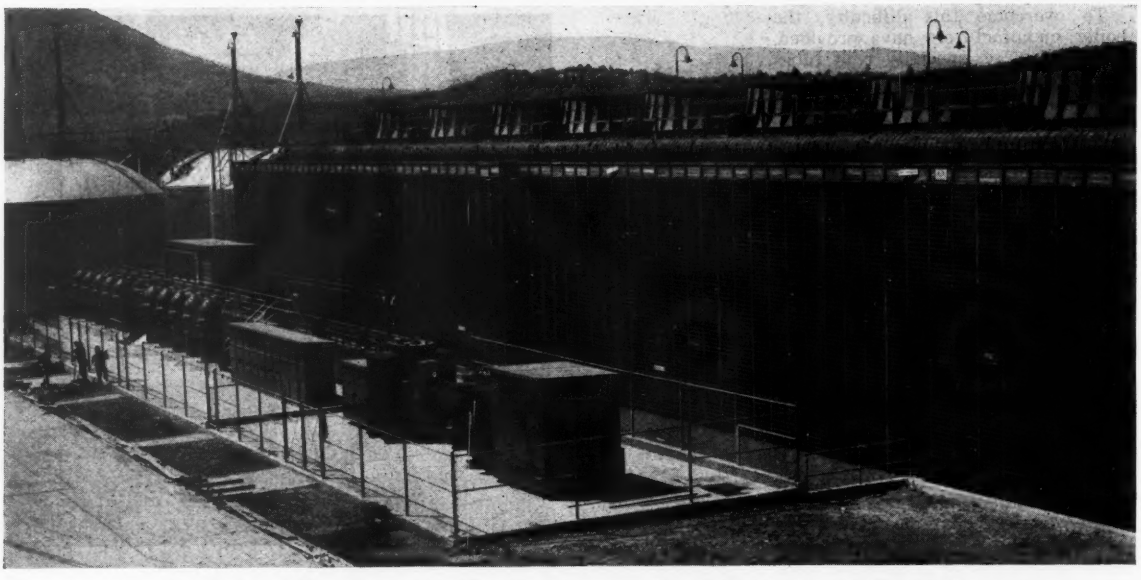


Fig. 7. New cooling tower, with cooling tower pumps and two unit sub-stations in foreground

angle acting as a rail on top of the wheels of the conveyor. If the conveyor should rise, due to obstruction from filled bunkers or packed coal, the wheels will lift this upper rail and trip the electrical circuit to stop the conveyor.

The skip hoist has now been enclosed in a metal hoist housing to make it dust-proof. This housing is vented. The skip hoist motor has been totally enclosed and made dust-tight by installing boxes over the end bells of the motor and ventilating it from outside the building.

Another improvement is the building of a feedwater testing laboratory on the boiler room operating floor level. Here the boiler room foreman and the record man can conduct all water tests and supervise the water treatment. The Hall water-conditioning system is used.

Refrigeration Capacity Increased

The capacity of the refrigeration plant has also been increased. As described in POWER PLANT ENGINEERING*, the original plant contained three 300-ton Carrier centrifugal refrigerating machines, one driven by a 600-hp, GE synchronous motor, the other two by Moore condensing-extraction turbines, taking steam at 410-psi, extracting at 25-psi and exhausting at 26-in. vacuum. To these were later added four Frick 175-ton vertical reciprocating ammonia compressors driven by GE synchronous motors.

The recent expansion of this capacity adds four new machines. These are Carrier centrifugals, each of 375-t refrigerating capacity and each driven by a Moore 620-hp non-condensing steam turbine, taking steam at 410-psi and exhausting at 25-psi. Although electrically driven compressors might have been more economical in this particular heat balance, they would have tied up about 2000-kw of generating capacity, hence the steam drives were used, since there is sufficient steam with the four boilers in service. Making the turbines non-condensing fitted the heat balance, which required additional 25-psi steam. Use of such turbines also saved the material and cost of condensers.

Providing More Generating Capacity

A very important part of the expansion program was to provide more electric generating capacity, as noted above, for two reasons:

1. The peak load on the power plant had been from 19,000 to 20,000-kw and, before the installation of the new generating units, the total installed generating capacity was 24,000-kw. Hence the need for additional capacity to assure continuity of service was obvious.

2. The latest spinning machines were being changed from high-frequency drive to a new type operating on 60-cycles.

Consequently, the 60-cycle load was greatly increased and the high-frequency load correspondingly decreased so that all the high frequency spinning machine load could

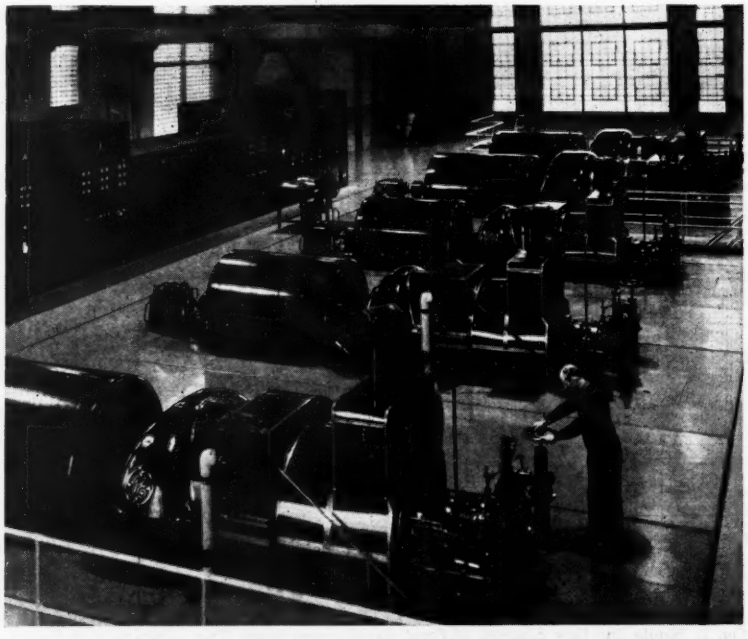


Fig. 8. Turbine room before installation of third 7500-kw, 60-cycle unit (see Fig. 3), which is placed just beyond first two 7500-kw units at far end of room. In foreground, three original 3000-kw high-frequency generators, one now being converted to 4000-kw, 60-cycle machine

be carried on one of the existing 3000-kw high frequency generators.

Consequently, it was decided to install a completely new General Electric 7500-kw, 60-cycle turbine generator. In addition, it was found that by making some blading changes in one of the high-frequency machine turbines and operating it at 3600-rpm it would be possible to replace its 3000-kw, 6-pole generator with a 4000-kw, 0.8-pf 2-pole, 60-cycle generator.

The new 7500-kw turbine was designed for non-condensing operation, instead of for condensing operation with 25-psi extraction, as are the two original 7500-kw units. This non-condensing unit fitted the heat balance, exhausting needed 25-psi steam to the 25-psi process steam header. Furthermore, at the time the unit was ordered and installed, war-time material shortages made it desirable to avoid using a condenser if possible.

3000-kw Unit Now Produces 4000-kw

In remodeling the 3000-kw unit to 60-cycle operation, the existing 6-pole generator, capable of generating 120-, 150- and 180-cycles at 2760, 3450, and 4140-v, is being removed and replaced by a General Electric two-pole 60-cycle, 6900-v, 0.8-pf generator. By removing the 2nd and 11th stage blades on the turbine, 4000 kw at 0.8 pf, at 3600 rpm can be obtained.

Five additional GE feeder cubicles have been installed to handle the additional electric circuits to the mill.

To meet the increased plant demands, the electrical distribution equipment has been expanded. The original installation had four substations, three for 60-cycles and one for high frequency. In 1940 another 60-cycle substation was added. These consisted of three single-phase, oil-cooled transformers, outdoors, with the usual high and low tension buses. The high and low tension switchgear was installed in a separate building adjacent to the transformers.

Eleven additional substations of the modern unit type have been added to the 60-cycle distribution, all but two of them being installed outdoors, either on the ground or on the roofs of the building as close to the center of load as it is possible.

The two indoor transformers are air cooled. Each transformer has a triple pole double throw magnetizing current break changeover switch on the primary (6900-v) side so that the transformer can be connected either to its own feeder, or in an emergency, or for servicing, to the 6900-v tie line which connects all of the substations. All of the substations have the low-tension distribution with metal enclosed cubicles and drawout type of air circuit breakers. One substation, which is connected to the 250-hp fume fan motors, and the 200-hp cooling tower pump motors, has 2300-v secondary with similar type switches. All outdoor substations are completely weather-proofed.

These substations are of Westinghouse manufacture and range from 300-kva to 2500-kva in capacity. They are arranged for future connection to a 440-v tie line, which we expect to install post war. The main 440-v circuit breakers are constructed for the future installation of relays to make them reversed current tripping. Of course, the 2300-v secondary and the three 208/120 lighting transformers (2-500-kva and one 750) are not arranged for the 440-v tie line connection. Each of the new power house cubicles has two feeders which take care of two substations. All distribution, both primary and secondary, is through 10-kv varnished cambric and lead cable in underground ducts.

We have installed an eleven-cell, 33,000-gpm Marley induced draft cooling tower for the Acid Reclaim Department, which is serviced by two sets of five vertical outdoor type supply and return pumps. For this unit, 50-hp two-speed fans furnish air.

Chicago Section ASME Holds Two-Day Meeting

Sessions June 18 and 19 substitute for semi-annual meeting . . . Gas turbine operating data featured . . . Steam cycles . . . Aviation . . . Test code for bearing greases . . . Metal cutting and production

RELEASE of authoritative operating data on gas turbines installed as component parts of Houdry process units in various plants of Sun Oil Co. was, for power engineers, the outstanding feature of the two-day meeting of the Chicago Section ASME, held June 18 and 19 at the Hotel Stevens, Chicago. Also disclosed were details of a 2000-kw closed cycle gas turbine plant, designed solely for electric power generation and considered to be adaptable to burning pulverized coal, erected and tested at Zurich, Switzerland by the Escher Wyss Co. Two papers covering these subjects are presented elsewhere in this issue.

For production mechanical engineers, representing the important war production processes carried on in Chicago, valuable papers were presented on various phases of metal cutting techniques, production-engineering, applied mechanics. A heat transfer session and a mangement session and an aviation session also evoked much interest.

For all types of engineers, another outstanding feature was the address on Personal and Personnel Problems of the Engineer by W. J. King at the informal dinner on Monday evening, June 18.

The two-day session was held to provide a method for discussing important engineering developments within the spirit and the letter of the ODT ban on national meetings. It replaced the semi-annual meeting of the ASME, originally scheduled for the same period at Chicago. However, by scheduling some of the semi-annual papers for the Chicago meeting and incorporating meetings of the executive committee of the ASME council, attendance was limited to local members and the out-of-town speakers and members of the council and standing committees accounted for the 50 outside members permitted to attend.

In the course of the meeting, J. C. Marshall, plant engineer, Proctor & Gamble Mfg. Co., Chicago, Ill. was elected president of the Chicago Section for the period July 1, 1945 to June 30, 1946. H. L. Nachman, professor of thermodynamics at IIT was re-elected secretary-treasurer and five vice-chairmen and seventeen members of the executive committee were also chosen.

At the luncheon on June 18, D. R. Shoults, vice president of Bell Aircraft Corp., presented interesting data on Airplanes of the Future and the Future of the Airplane.

Steam Cycles

Irreversibility in the Theoretical Regenerative Steam Cycle was the subject of a paper by R. E. Hansen, mechanical engineer, Ebasco Services, Inc. He showed how, in the theoretical regenerative steam cycle for power generation, an irreversible process takes place when superheat in the steam bled from the turbine is transferred to the feedwater. Increase in entropy occurs in this process as in any irreversible process. This increase can be determined by a method of graphic integration and used in computing additional heat rejection to the condenser. The heat rate of the cycle can then be found with a high degree of accuracy by a simple formula. Computations of heat rates are shown in the paper.

In discussion of the paper it was brought out that certain approxima-

tions in the differential equations and integrations introduced only slight inaccuracies, which can be neglected. It is proposed to set up factors for obtaining the actual cycle, with a finite number of feedwater heaters, from the theoretical cycle, in which an infinite number of extraction heaters is assumed.

Personal Problems of Engineers

W. J. King of Battelle Memorial Institute brought out clearly and objectively some points on the relations of the engineer to industry and society that concern every engineer, regardless of his special technical interests.

On the basis of many interviews with individual engineers, and a considerable body of evidence collected from many industrial organizations, Mr. King advanced the following ideas.

Industry expects of the engineering employee certain characteristics such as loyalty, enthusiasm, full application to the business of the company, definite contributions to the company's program, consistent application of initiative, planning and teamwork. It feels it has a right to expect assignments to be finished on time and within the budget and that engineers will record and report the results of their work for the benefit of others in the organization. It expects good personal appearance and good personal ethics and, while an engineer's private affairs are his own, his social conduct is to a considerable extent the company's business.

Turning to what engineering employees expect of industry, Mr. King said he had found that, to most engineers, just more salary is not enough. They want guidance in their techniques, opportunities for progress, clear assignments and responsibilities, proper tools for the job. They expect information on the company's program or policies, on how they are getting along, evidence of interest in their work, good working conditions, freedom from petty annoyances. Opportunity to advance their professional societies and education, contacts with other men and other plants are considered important.

It is when management is so ill-advised as not to recognize the importance to the engineer of such factors that the question of bargaining between the engineer and management arises, bringing the engineer squarely into the field covered by the Wagner Act.

The speaker discussed this act as it applies to engineers.

A disadvantage of the national engineering organizations as collective bargaining agencies, the speaker said, is that their membership includes both management men and employees. A true bargaining unit for engineers should be homogeneous and of professional status, without admixture of non-professionals.

However, most engineers will prefer to co-operate collectively with management rather than to bargain collectively. An independent organization without certification under the Wagner Act is sometimes preferred for this purpose.

The speaker stated his belief that there is a manifest opportunity for the ASME to take the initiative in guiding the members in their thinking on this very important question.

Aviation Gas Turbines

Comparisons of the performance, limitations and most favorable spheres of application for various prime movers in aviation were given in a paper on the Place of the Gas Turbine in Aviation by C. D. Flagle and F. W. Godsey, Jr., of Westinghouse Electric Corp., presented by the latter. The reciprocating engine, most widely used at present, will doubtless continue to hold its present position in the field of low power and for planes of relatively low speed, the gas turbine will come into its own both as a jet engine and for driving propellers in high-powered planes and for high-speed flight.

Another paper on the Gas Turbine in Aviation, Its Past and Future by Puffer and Alford, Supercharger Engineering Department, General Electric Co., presented additional data on the relation between speeds, altitudes and performance factors of the jet and gas turbine propeller engines. This paper included some data on the compound engine; that is, the reciprocating internal combusttion engine discharging its exhaust gases at high temperature to the inlet of a gas turbine, which delivers its power through gearing to the engine shaft. In the discussion of the paper, it was stated that this type of engine might have considerable importance for long range operation in the future, although so far it is not in production. It was also brought out that gas turbine and jet engines up to 10,000 hp capacity were a possibility and on the other hand that it might be possible to build them in sizes as small as 200 hp.

A new type of electric micrometer which was developed to test the performance of precision lathe spindles, and which acts like a miniature radio station, was described by G. M. Foley, research engineer of the physics department of Battelle Memorial Institute, Columbus, Ohio.

Advocates Test Code for Bearing Greases

H. A. McConville, engineer of the General Electric Co. of Schenectady, advocated that a test code be evolved for evaluating ball and roller bearing greases for electric motors. A test procedure used by General Electric was outlined in the hope that it might be of value to industry.

"It has been said that many ordinary grades of grease will be satisfactory for about 95 per cent of the bearing applications," Mr. McConville said. "It is the other 5 per cent of bearings which operate under unfavorable conditions such as extremely high speeds, high or low temperatures, etc., that give trouble. The selection of a grease that will give satisfactory lubrication over all ranges of conditions is the aim of most grease consumers. Some greases will have wider ranges than others, and extending their limits is a step towards the ideal."

Support Lower Speed Steel Milling

An Investigation of Radial Rake Angles in Face Milling was the subject of a paper by two engineers of the Kearney and Trecker Corp. of Milwaukee, J. B. Armitage, vice-president in charge of engineering, and A. O. Schmidt, in charge of metal cutting research. The authors set forth reasons based on numerous production operation setups showing advantages of lower cutting speeds for carbide steel milling as opposed to those from 1000 to 3500 surface feet per minute frequently recommended.

The development of a new electric drive for the turret of the General Sherman tank, with acceptance tests completed on the eve of Pearl Harbor, with "truly providential timeliness," was described by Stanley J. Mikina, engineer with the Westinghouse Research Laboratories.

By utilizing the previously developed Silverstat control, together with gyroscopic means for elimination of unstable oscillations, a positionally-regulated drive was created which enabled the tank gunner to point the turret gun over the full circle of travel with the same facility as if he were aiming a light rifle. A force of two pounds on the control handwheel was sufficient to move a heavily-armored turret weighing 12,000 lb.

Design of Beams

I. Opatowski, engineer of the Armour Research Foundation, Chicago, presented a paper on Design of Beams of Long Span and Low Specific Strength. He gave methods for the cantilevers of uniform strength in bending in those cases in which the weight of the beam cannot be neglected in calculating the bending moment. This occurs in concrete structures where the span is large and the strength of material relatively low.

Heat Transfer from a Cylindric Surface to Air was discussed in a paper by Max Jakob, Illinois Institute of Technology, and W. M. Dow, Armour Research Foundation.

The two-day session closed with the annual dinner of the Chicago Section ASME. F. H. Lane, chairman of the Chicago Section, presided. Alex D. Bailey, president of the ASME, delivered a short address and then introduced the guest speaker, Robert E. Wilson, Chairman, Board of Directors, Standard Oil Co. of Indiana. Mr. Wilson gave many technical details of America's Future Oil Supplies.

Gas Turbine Operation in Sun Oil Refineries*

By

Arthur E. Pew, Jr.

Vice-president, Sun Oil Co.

Seven units installed as components of Houdry process . . . First unit installed 1936, operated 2607 days, with 50 days or 1.88% of time out for turbine trouble . . . Average availability of units over 98% . . . Bearing troubles cured by use of Kingsbury bearings . . . Lubrication troubles overcome . . . Units of 23,000-40,000 cfm operate at 800-950 F inlet gas temperature . . . Maintenance and repair not over 3% of investment a year . . . Investment returned in 3 years . . . Low-cost electric power a by-product . . . Operating record justifies further use of gas turbines in connection with regeneration of Houdry catalysts

THIS PAPER reports on the operation and maintenance record of seven gas turbines installed by Sun Oil Co. in its oil refineries for the propulsion of axial air compressors. The compressors supply high pressure air in connection with the catalytic cracking of petroleum for the manufacture of 100-octane aviation fuels and high-octane motor fuels.

General Facts

Prior to 1936, Sun engineers, working in conjunction with the Houdry Process Corp., adapted the Brown-Boveri gas turbine and axial compressor to supply air in large quantities and at comparatively high pressures for catalyst regeneration in the Houdry process of catalytic cracking. At the Marcus Hook, Penna., Refinery of Sun Oil Co., there was placed in operation, in the latter part of 1936, the first successful large gas turbine unit in the United States.

In the Houdry catalytic process for aviation and high octane gasoline, it is necessary, for maximum efficiency, to maintain the catalyst in a state of high catalytic activity. For plants charging to the catalyst approximately 10,000 bbl per day, the air requirements are approximately 40,000 cfm at 45 psi gage. To obtain this quantity of air at this pressure, approximately 5,600 hp is required. This Houdry process is shown diagrammatically in Fig. 1.

*Paper presented before Chicago Section Meeting, ASME, June 19, 1945.

Table I. Turbo-compressors in service on static bed Houdry units in U. S. on June 19, 1945

Company	Location	Turbo-Compressors Nominal Rating No.	CFM	Manufacturer
Sun (11-4)	Marcus Hook	1	40,000	Brown-Boveri
Magnolia	Beaumont No. 1	1	23,000	Brown-Boveri
Sun (12-3)	Marcus Hook	1	40,000	Brown-Boveri
Socony	Trenton, Mich.	1	23,000	Allis-Chalmers
Socony	Brooklyn, N. Y.	1	23,000	Allis-Chalmers
Sun	Toledo, Ohio	1	40,000	Allis-Chalmers
Magnolia	Beaumont No. 2	1	40,000	Allis-Chalmers
Socony	Buffalo	1	23,000	Brown-Boveri
Socony	E. St. Louis, Ill.	1	23,000	Brown-Boveri
Socony	Augusta, Kansas	1	23,000	Allis-Chalmers
Socony	Paulsboro, N. J.	1	23,000	Brown-Boveri
Sun (12-3 Ref.)	Marcus Hook	1	*23,000	Allis-Chalmers
Sun (10-3)	Marcus Hook	2	40,000	Allis-Chalmers
Tide Water	Bayonne, N. J.	1	60,000	Allis-Chalmers
Socony	E. Chicago, Ind.	1	23,000	Allis-Chalmers
Std. Oil of Calif.	El Segundo, Cal.	1	40,000	Allis-Chalmers
Gulf Oil Corp.	Port Arthur	1	40,000	Allis-Chalmers
Sun (15-1)	Marcus Hook	1	40,000	Allis-Chalmers
Sinclair Ref.	Houston, Texas	1	40,000	Allis-Chalmers
Magnolia	Beaumont No. 3 & No. 4	2	23,000	Allis-Chalmers
Sinclair Ref.	Corpus Christi	1	40,000	Allis-Chalmers
Southport Pet.	Texas City, Texas	1	40,000	Allis-Chalmers
Std. Oil Ohio	Cleveland, Ohio	1	40,000	Allis-Chalmers
Std. Oil Ohio	Cleveland, Ohio	1	23,000	Allis-Chalmers

*23,000 cfm casing with blades cut for 16,000 cfm output.

SUMMARY

Nominal Rating CFM	Number
23,000	12
40,000	13
60,000	1 Total—26

Extent of Use

As of this date, there are in use in the United States, twenty-six gas turbine units on Houdry cracking plants, as shown in Table I. Twelve units are of 23,000-cfm normal rating, thirteen units of 40,000-cfm, and one of 60,000-cfm rating.

In Sun Oil refineries, seven gas turbo-compressor units have been installed, the first one in 1936 and the most recent in 1943 as shown in Table II.

Description of Sun Units

The gas turbo-compressor units as used by the companies listed in Table 1 are all of the same general design, other than capacity. The principal specifications are as follows:

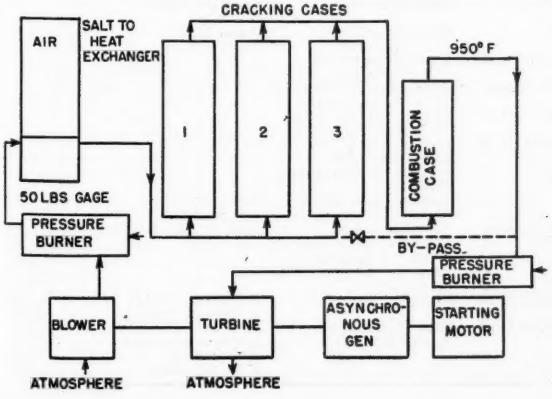


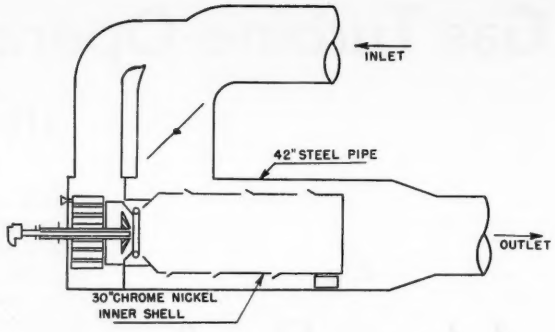
Fig. 1. Schematic air flow sheet of Houdry process involving gas turbine

In the Houdry process, oil is vaporized and passed through a catalyst. As one of the results of the chemical changes which occur, carbon is deposited on the catalyst. The efficiency of the catalyst is decreased by such deposits, which must be periodically removed. The catalytic containers are arranged so that the operation of carbon removal is continuous, on a cycle basis, certain containers being regenerated while others are operating on the oil cycle. The cycles from container to container are automatically controlled on a predetermined basis.

The carbonaceous deposit is oxidized by the air from the compressor and the products of combustion passed to a gas turbine, which in turn drives the axial compressor supplying air at 45 lb pressure to the catalyst regeneration units. The heat content of the products of regeneration exceeds the energy necessary for the compression of the regeneration air. The excess is recovered as electric power and steam for use in the process. In the usual installation, gas temperatures at the turbine inlet are 875 to 950 F and are exhausted at about 550. Inlet pressure to turbine is about 40 psig and outlet pressure of compressor is about 50 psig.

Fig. 2. Arrangement of combustion chamber for gas turbine

Air at a temperature of approximately 350 F and 45 lb pressure from the outlet of the air compressor enters the combustion chamber through a 30 in. pipe. The air flow is divided at this point, a portion of it passing through an air register and thence to the oil burner for combustion. The balance of the inlet air passes through a control damper and around the outside of a 30 in. chrome nickel shell inserted in the 42 in. steel pipe. The inner shell has a number of perforations arranged to cause an infiltration of air into the inner shell in such a manner as to create a swirling and mixing action within the inner shell and thereby cool of the shell walls. The products of the combustion and the excess air mingle at the outlet of the 42 in. pipe section and pass therefrom to the catalytic cases for regeneration of the catalyst. The temperature of the mixture is approximately 950 F and the temperature within the inner shell is approximately 2000 F. The air capacity of the burner is approximately 40,000 cfm at 45 lb pressure. No refractory material is used. This type of burner has operated for a number of years with entirely satisfactory results. The design is an adaptation by Sun engineers from the basic design of Brown-Boveri.



Capacity compressor unit
(based on 60°), cfm..23,000-60,000
Suction pressure
(based on 60°).....atmospheric
Discharge pressure, lb gage... 45
Turbine gas quantities, 40,000
cf size, lb per min..... 3,170
Pressure, turbine inlet, lb gage 40
Temperature, turbine, inlet.800-950 F
Speed of set, rpm..... 5,180
Weight of set, 40,000-cfm size,
lb 70,000
Equipment required for the 40,000-cfm turbo-compressor units installed at the Sun Oil Co. is shown in Table III.

Table No. 4 shows the material used in the construction of the principal parts of the turbo and compressor units.

Method of Operation

Figure 1 shows diagrammatically the arrangement of gas turbine, blower, generator and starting motor or turbine, interconnected with a catalytic cracking unit. In starting up, the turbine is rotated at approximately 2,000-rpm for several hours by means of the starting motor or starting steam turbine, while bearings are warmed up and equipment checked. During this time the air delivery from the compressor is circulated through a bypass to the turbine.

After partial speed, i.e. 25 to 30 per cent of normal, has been reached and the units checked, the temperature is brought up by the pressure burner preceding the turbine. The volume of air being circulated and the pressure are raised over a period of 8 to 10 min by gradually bringing the unit up to its full speed of 5,180-rpm. The heat of the discharge air is then gradually raised by the air heater located on the discharge side of the compressor and the air thus heated is passed to the catalytic cases.

Following this, the gases from the catalytic cracking case, resulting from the regeneration of the carbonaceous deposits, supply the energy for the operation of the turbo-compressor unit, and pressure burners are shut off.

Under normal operating conditions, the amount of excess power supplied to, or developed by, the unit depends upon the type of catalytic cracking reaction being practiced. For example with increase in carbon deposition, power will increase. In general, with air temperature at 60 F to the compressor and with gas temperature to the turbine at 950 F, the 40,000-cfm units will generate up to 900-kw excess over required power for driving the compressor.

Table II. Turbo-compressor installations of Sun Oil Co.

Location	Cap. Std. cfm	rpm	Means of Starting	Date in Service	Type Thrust Bearing
M.H. 11-4[a]	40000	5180	Motor	Dec. 1936	*Angular contact ball
M.H. 12-3[a]	40000	5180	Motor	July 1939	do
Toledo 3[b]	40000	5180	Motor	Aug. 1939	do
M.H. 12-3[b]	16000	6050	Turbine	Nov. 1940	do
M.H. 10-3[b] N	40000	5180	Turbine	Dec. 1940	do
M.H. 10-3[b] S	40000	5180	Turbine	Jan. 1941	do
M.H. 15-1[b] S	40000	5180	Turbine	Aug. 1943	Kingsbury

All compressors 45 psi discharge pressure. All units have 1500 hp synchronous motor generators except 16000 cfm has 500 hp.
*Angular contact bearings removed. Kingsbury installed since 1943. Remaining units all equipped now or being equipped with Kingsbury bearings.
[a]Manufacturer: Brown-Boveri; [b]Manufacturer: Allis-Chalmers.

Service Record

Table V shows the number of operating days on each of six Sun Oil installations in relationship to the number of days shutdown on account of turbo-compressor difficulties. The plants are listed in the order of their installation.

Under the heading "Days off account turbo trouble" is included time chargeable to the complete turbo-compressor unit and the equipment in connection therewith necessary for operation. The time shown represents the time required for making repairs. It is believed by the operating division of Sun Oil Company that time off due to turbine troubles and troubles in connection with turbines have not been excessive under the conditions encountered.

Failures Causing Turbo-Compressor Outages

Table VI shows failures causing outages in the order of their prevalence.

Table VII classifies failures causing turbo-compressor outages in relation to number of failures and days lost for each type of failure.

Out of 46 failures, 29 were caused by bearing trouble and out of the 179 days lost time from all causes, 101 days were due to failures of bearings. Table II shows the type of bearings installed in Sun units. It was found early that angular contact ball bearing type of thrust bearing was not satisfactory for the conditions encountered. The angular contact bearings have all been replaced with the Kingsbury type thrust bearing with the exception of one unit at Marcus Hook which is now being changed.

Table III. Equipment used in 40,000-cfm turbo-compressor units, Sun Oil Co.

Gas Turbine	Brown-Boveri or Allis-Chalmers	6200 hp-950 F reaction type 5 stages
Compressor	Brown-Boveri or Allis-Chalmers	Axial type 20 stages
Governor & Oil Pump	Brown-Boveri or Allis-Chalmers	
Auxiliary Oil Pump	Brown-Boveri, Roper, Allis-Chalmers	
3% Overspeed valve	Brown-Boveri, Allis-Chalmers, Republic	
10% Overspeed valve	Brown-Boveri or Allis-Chalmers	
Oil Coolers	Andale or Griscom-Russell	
Oil Filter	Nugent cloth filter Shriver blotter press	(emergency) (normal opr.)
1500-hp Syn. motor Starting Units	Allis-Chalmers Motors, Allis-Chalmers, or General Electric. Steam Turbines-Moore	2300 v-1792-rpm
Reduction Gear Unit	Moore	Between starter & 1500-hp motor
Reduction Gear Unit	Falk Herringbone or Brown-Boveri	Between 1500-hp motor and turbo-compressor 5166 to 1800

Table IV. Materials used in turbo-compressor units, Sun Oil Co.

Sealing strips	18 chrome-8 nickel (originally were nickel)
Gas turbine blades	Stainless steel
Compressor blades	Nickel steel
Gas turbine spindle	Chrome nickel steel forging
Gas turbine cylinder	Molybdenum cast steel
Compressor spindle	Steel forging
Compressor cylinder	Cast iron
Bed plate	Cast iron

There have been no thrust bearing failures or bearing repairs since the Kingsbury type has been installed. The first Kingsbury bearing was installed on a Sun Oil unit in June, 1942, and has been in satisfactory operation since that time. The other units were converted at various times in the interval. In view of the record of no failures, it is believed reasonable to assume that this type of bearing is satisfactory for these units. It may fairly be assumed that if Kingsbury thrust bearings had been used from the beginning, the total time lost would have been reduced approximately 60 per cent.

Lubrication difficulties caused a loss of 28 days with 6 failures due to lubrication. Lubrication difficulties were caused by dirt in the oil sprays, condensate in the oil, broken shafts in main oil pumps as the result of bearing failures, and failure of auxiliary oil pumps to start when main pump failed. It is believed that lubrication difficulties have been largely overcome by the installation of blotter presses; there have been no lubrication failures since these installations have been made.

Failure of blades in either the compressor or the turbine was responsible for 4 shutdowns of 19 days lost time. These failures are caused by blades becoming loose as a result of an arginal design in which the blade was not integral with the root. Later designs by the Allis-Chalmers Co. have provided an integral root blade, and no trouble has been observed in over 22 months' operation in a Sun unit with this type of blade. There has been some trouble noted from erosion of the gas turbine blades due to fine particles of catalyst being present in the gases or small deposits of carbon dust. Experimental work is being done to eliminate this condition by trapping the air entrances to the turbine. The erosion noted has not been of sufficiently great extent to be an important problem.

The tables indicate one shutdown of 3 days' duration for failure of air seals. Air seal strips are subjected to rubbing due to change in alignment and gradually wear out. These may be replaced during a normal shutdown without excessive difficulty and are not considered as being a weakness which might necessarily cause shutdowns. However, improvements in air seals become more important as shutdowns for other causes are eliminated.

There have been 3 shutdowns of 12 days' duration total due to explosions. **These explosions are not due to turbine design,** but are the result of errors in operation or failures in handling other parts of the equipment serviced by the turbines. None of the three explosions was of sufficient intensity to rupture the equipment.

There were 3 shutdowns of 16 days' duration due to errors in maintenance. In one case, a foreign object was left in the air compressor, causing blading to be stripped.

Bearing failures, lubrication failures, and blading failures are the three principal causes of shutdowns and accounted for 148 days lost time out of the total of 179 days and for 39 shutdowns of the total of 46. It is believed that the changes described above have satisfactorily and substantially eliminated these causes of shutdowns.

Table V. Summary of turbo-compressor operation, Sun Oil Co., to May 31, 1945

Location Plant	Operating Days	Days Off Acc't. Turbo Trouble	Total Days	% Time Turbo Trouble
11-4	2,607	50	2,657	1.88
12-3 C	1,900	21	1,921	1.09
12-3 R	1,413	45	1,458	3.10
10-3 N	1,404	34	1,438	2.36
10-3 S	1,365	29	1,394	2.08
15-1 S	569	0	569	0.00

Table VI. List of failures causing outages in Sun gas turbines

(1) **Bearings**
Thrust bearings.
Spring rings (roller bearings).
1500 HP motor bearings.

(2) **Lubrication**
Dirt in oil sprays—causing bearing failures.
Water in oil (condensate) causing bearing failures.
Main oil pumps—broken shaft spline as result of bearing failures.
Auxiliary oil pump—failure to start when main pump failed.

(3) **Blades**
Loose blades—latest design with integral root, no loose blades in 22 months on one unit.
Erosion—gas turbine blades.

(4) **Air seal material strips** (failure does not necessarily cause shutdown).
Rubbing, due to change in alignment.
Expansion joints—harness.

(5) **Explosions**
11-4 bypassing air into oil vapors—experimental case.
12-3 reformer—air bypassed into oil vapors.
12-3 cases—gas explosion—gas burner opened by mistake.
10-3 dirty oil burner—no atomization.

(6) **Miscellaneous**
Foreign objects in compressor or turbine.
Failure to synchronize before cutting motor in when starting unit.

Table VII. Classification of failures causing outages on Sun turbo-compressor units

	Bearings		Lubrication		Blades		Air Seals		Explosions		Misc.		Total	
	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days
11-4	18	43	—	—	—	—	—	—	1	5	1	2	20	50
12-3 C	4	12	—	—	1	4	1	3	1	2	—	—	7	21
12-3 R	4	31	3	14	—	—	—	—	—	—	—	—	7	45
10-3 N	3	15	3	14	—	—	—	—	1	5	—	—	7	34
10-3 S	—	—	—	—	3	15	—	—	—	—	2	14	5	29
15-1	—	—	—	—	—	—	—	—	—	—	—	—	0	0
Tot.	29	101	6	28	4	19	1	3	3	12	3	16	46	179

Important Considerations in Installation of Gas Turbine Units

Probably the most important consideration with regard to installation arrangement is ample provision in the piping to reduce piping strains to a minimum. The piping to the turbine and compressor units is unusually large; the air inlet to the compressor on the 40,000-cfm machine is 36-in. and the air outlet 30-in. The gas inlet to the turbine requires a 30-in. pipe and the exhaust a 36-in. pipe.

Due to the high temperatures of the piping to the turbine, provision must be made to handle the expansion and contraction, for the machine is relatively light in construction and the speeds high, making it essential that the alignment be accurately maintained.

Design of the burners used for starting the turbo-compressor requires careful consideration. Figure 2 shows the arrangement of the combustion chambers ahead of the air heater and the turbine.

Arrangements of valves, control instruments, etc., have been worked out on the basis of experience and have given satisfactory results. The installations are not complex and involve no special operating or maintenance difficulties.

Maintenance Costs

The cost of maintenance and repairs of the various units listed in this report have varied from a high of approximately $1,000 a month to a low of $300. Maintenance and repairs may be conservatively estimated on units as they are now developed as not in excess of 3 per cent per year of capital investment. The most costly repair is the reblading of the gas turbine which, under present conditions, is estimated at $13,000 of which approximately $12,000 is for blades. The cost of cleaning the units has averaged about $300 per year.

Summary

The operating record of the gas turbo-compressor units of Sun Oil's plants have been such as to justify, in the opinion of Sun's engineering organization, the continuation of the use of this type of equipment in future installations. The cyclic opera-

(Continued on page 122)

2000-kw Gas Turbine Plant for Power Generation[1]

Employs aerodynamic turbine, using heated air as working fluid . . . This is often called the closed cycle gas turbine[2] . . . Test plant developed, operated and tested at Escher Wyss Engineering Works, Zurich, Switzerland . . . Considered adaptable for burning pulverized coal . . . Air heater plays part of boiler in steam plant . . . Small cooling water requirements . . . Full load thermal efficiency, fuel to coupling output, 31.6 per cent; heat rate, 10,790 Btu per kw-hr . . . Same design advocated for single-shaft units up to 100,000-kw capacity

AFTER EXHAUSTIVE thermodynamic studies and calculations for ascertaining the most suitable pressure and velocities and after many preliminary tests on separate elements of machines and apparatus, construction of a thermal test plant employing the aerodynamic turbine, often called the closed cycle gas turbine, was commenced in the works of Escher Wyss, Zurich, in the year 1936.

The plant, according to Dr. C. Keller, head of the Research Department of Escher Wyss, was calculated for an output of about 2000 kw, i.e. of industrial dimensions, thus permitting the actual performance of the new process to be tried out under conditions such as are experienced in practice. For simplicity and to prove the usefulness of the new circuit process in itself, oil heating of the air heater was adopted in the first instance, but burners of novel design employed. There is no principal difficulty in providing for conversion later to coal firing.

The plant is primarily a testing and experimenting installation in the design of which less attention has been paid to minimum space requirements and pleasing arrangement, but more to good accessibility and the possibility of easily replacing various parts, also of supervising its operation by exhaustive measurements. Consequently its external appearance is not in all respects characteristic for later installations of this kind. On the basis of present knowledge and project studies which have been made, the design can be rendered much more compact and simple.

All components of these AK-plants, such as the turbines and compressors, heat exchangers and air heaters, form part of the actual manufacturing program of Escher Wyss. All these components could be developed and built in the firm's own works on the basis of experience and the latest research results oftained in the company's laboratories.

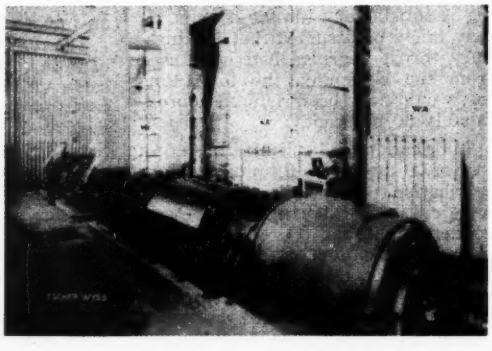


Fig. 1. Escher Wyss 2000-kw aerodynamic turbine test plant

The test plant was first operated in the summer of 1939 and ran from the very first without any fundamental deficiencies, so that the working principle could be maintained without alteration. During the last few years various parts of the plant have been modified and systematically improved on the basis of many hundred hours of trial operation. Present circumstances made it necessary for us to adopt a careful and gradual process in making these trials, in order not to endanger parts of the plant made of special metals, such as tubes capable of resisting very high temperatures and turbine runners which, if damaged, would be irreplaceable in wartime.

General Arrangement

Figure 1 illustrates the general arrangement of the test plant. The simplified circuit is illustrated by Fig. 2. Hot air turbine T drives compressor K and at the same time gives up its surplus energy externally to the generator G. Of 100 per cent total turbine output, 60 per cent is needed for driving the compressor while 40 per cent goes to the generator. Air compressed in the compressor and still relatively cold is passed through the heat exchanger WA, in which it is heated by waste air from the turbine to about 660 F. It then flows into the tubes of the air heater where its temperature is further raised to 1200 to 1300 F by external heating. Under a pressure of approximately 340 psi it passes on to the turbine where it expands and gives up output.

On leaving the turbine the temperature is still appromixately 750 F and the pressure 85 psi. The heat of the waste air is given up to the recompressed air coming from the compressor. The cooled waste air of the turbine, after being further cooled in precooler VK, is led back to the suction branch of the compressor, where the circuit is again begun under a pressure of 85 psi.

Turbine T comprises a high-pressure and a low-pressure turbine, through which the working medium flows one after the other. The first turbine section drives alone the 8000-rpm compressor; the second drives the 3000-rpm generator. Expansion in the turbine takes place direct and without intermediate heating.

The highly heated air passes from the air heater (LE) through two vertical and well-insulated pipes to the high-pressure turbine. The remaining connecting pipes to the various machines are led underneath the floor.

High-Temperature Piping

From the air heater the hot air passes into two parallel hot air pipes to the high-pressure turbine. Since high temperatures are employed the

[1] Abstract of paper contributed by Oil and Gas Power and Power Divisions, ASME before Chicago Section, ASME, June 19, 1945. The paper was in turn abstracted by R. T. Sawyer, chairman of the Gas Turbine Co-ordinating Committee of the Oil and Gas Power Division from data furnished by the Escher Wyss Engineering Works, Zurich, Switzerland.

[2] See Power Plant Engineering, May, 1944, page 99.

external radiation losses must be reduced as far as possible, especially for small outputs. Consequently these parts are of special design. A thin-walled inner tube, capable of resisting high temperatures, serves only for guiding the hot air. This internal tube has fine bores towards the insulating space so that it is always relieved of this pressure. The heat protecting space is surrounded by the shell tube proper which is of standard metal. It has thick walls and can easily take up the pressure of the working medium, i.e. in this case 340 psi, since it is protected by the insulation from the internal tube and is consequently cold. With this double-tube design, a very great saving in expensive high temperature steel is realized.

The casing of the high-pressure turbine, also the runner, are made of chrome-nickel steel to withstand high temperatures. The air gains access to the first runner wheel on the left, without passing through stop valves or regulating valves. As a result of the small heat drop of the process—1/4 to 1/5 that of steam turbines—the two turbines have only a few stages, namely, six in the illustrated high-pressure turbine. All stages have full admission. Sealing between the rotating shaft and the casings both in the turbines and compressors, is by a combination of labyrinth glands and sealing air.

Machine Dimensions Small

Since all the machines operate at a pressure above atmospheric, their dimensions are extraordinarily small, so that very large unit outputs of 50,000 and 100,000-kw can from the point of view of tensile strength be readily dealt with. The mean external diameter of the high-pressure turbine rotor in the test plant amounts to only 13¾ in.

After its passage through the heat exchanger the expanded air has been cooled down to approximately 210 F. It is then passed through a so-called precooler which is water-cooled and of similar design to the heat exchangers and reaches the suction branch of the compressor with a temperature of about 70 F. This cooling of the air is necessary to reduce the work of the compressor as much as possible.

The compressor is a multi-stage axial unit. The air flows through the impellers in an entirely axial direction. As a result of the slight deflection and the careful aerodynamic profiling of the blade sections, the efficiencies are high. After passing through a few stages, the air is continually recooled in water coolers to its initial temperature. The whole compressor comprises three casings. The compressor rotors all run at 8000 rpm. This high speed leads to extremely small dimensions. The diameters of the rotors amount to 10⅝ in. to 15 in.

The air compressed in the compressor flows back to the heat exchanger and, after having been preheated in the latter, to the inlet of the air heater, where the initial point is again reached.

Table showing summary of performance trials on 2000-kw aerodynamic turbine plant, December 13 and 14, 1944

Load	about	1/5	2/4	3/4	4/4
Generator output (at terminals)	kw	418	967	1591	2044
Generator efficiency according to SEV	%	93.7	96.3	96.8	96.7
Output at coupling according to SEV	kw	446	1005	1644	2111
Total power requirements of the auxiliaries	kw	18.9	31.2	53.1	75.1
Net output measured at the terminals	kw	399.1	935.8	37.9	1968.9
Temperatures at HP turbine inlet	°F	1288	1279	1276	1268
Pressures at HP turbine inlet	psi	83.8	168.2	267.7	343.0
Total pressure ratio of turbines		3.57	3.56	3.56	3.57
Specific fuel consumption based on net output	kg/kwhr	0.371	0.298	0.287	0.278
at terminals	lb/kwhr	0.820	0.658	0.635	0.614
Lower calorific value of the fuel in Btu/lb			18450		
Thermal efficiency including auxiliaries (fuel to coupling output)	%	24.4	29.5	30.5	31.6
Thermal consumption per useful kwhr	Btu/kwhr	13960	11560	11190	10790

Burning Pulverized Coal

The heating of air heaters by means of pulverized coal is provided for as in Fig. 3. The ash can be removed from the combustion chamber in liquid or granulated state. By means of flue gases reconveyed into the heating chambers, the temperature of the combustion chamber can be reduced to such an extent that the air heater tubes can be subjected to the combustion temperature without special cooling. Flue gases issuing from the combustion chamber again pass through the heating chambers as a counter-current to the working air of the circuit. In spite of the high velocity of the working air inside the tubes, special layouts permit pressure losses to be greatly reduced at points of high temperature.

The plant has been built with due consideration of its use as a test installation. In the case of future industrial plants it will be possible to provide for simplifications. For example an industrial plant of 12,000 kw output for operation under a working pressure of 425 psi and 1200 F would have a layout as in Fig. 4. The heat exchanger is arranged immediately underneath the machine. The whole plant is supported on a simple foundation.

Results of the Official Performance Tests

By Prof. H. Quiby
(Swiss Federal Institute of Technology, Zurich)

The official taking-over tests took place on the 13 and 14 December, 1944. Measurements of the electrical output were made by officials from the testing department of the Association Suisse des Electriciens. Results of the tests are shown in the table. The test plant still has sources of loss which could be eliminated in a new installation of the same output, and I thus feel convinced that for the same testing conditions an efficiency of 33 per cent could easily be attained.

The efficiency curve takes a very gradual downward course from the normal load figure. Thus the efficiency still amounts to 24.5 per cent at approximately one-fifth of the full-load. To fully appreciate the importance of these figures, one must compare them with those of an up-to-date steam turbine plant of the same output which has approximately 22 to 24 per cent efficiency at normal load, with a sharp drop at part-loads.

The reason for this lies in the method of regulation which keeps the pressure ratio constant, while the temperatures do not vary. The machines have no stop valves either at the inlet or outlet. Regulation is effected simply with the aid of the by-pass valve, or by the valve which connects the circuit to the air accumulators. The fact that all these valves are traversed only by a current of cold air is worthy of note.

The auxiliaries comprise:

1 Cooling Water Pump
1 Combustion Air Fan
1 Flue Gas Fan
1 Circulating Gas Fan
2 Groups of Fuel Injection Pumps.

The total power consumption of all these auxiliaries amounts to 1.5 per cent of the total coupling output of the plant. The oil pumps which are not driven direct from the machine shaft were fed from an auxiliary generator which was driven by V-belts from the machine shaft. Exact determination of the power input, which

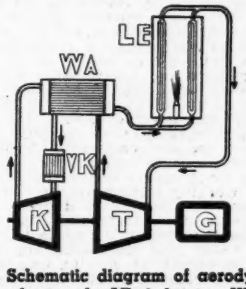


Fig. 2. Schematic diagram of aerodynamic turbine plant cycle. LE-air heater; WA-heat exchanger; G-generator; K-compressor; T-low-pressure turbine, high-pressure turbine behind T; VK-precooler

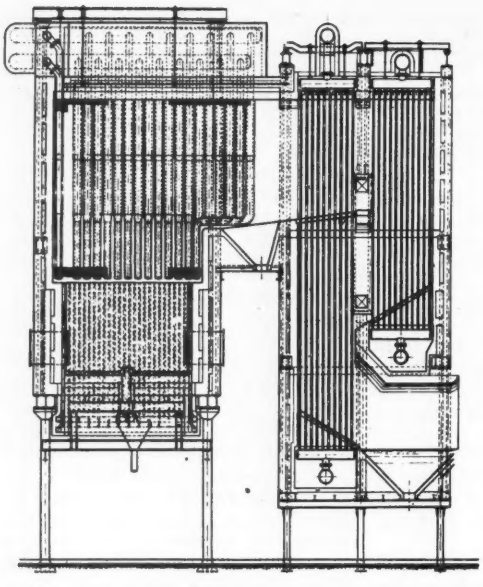


Fig. 3. Air heater of aerodynamic turbine plant, designed for burning pulverized coal

incidentally is less than 4 kw, has no influence on the total overall efficiency. The quantity of leakage air was ascertained by means of VDI standard diaphragms at the respective pressures.

As regards the functioning of the regulating gear[3] this was observed and recorded by means of registering instruments, also by checking the pressure in the accumulator. Even in the case of sudden changes in load of 600 to 700-kw, the reduction in speed was less than 1 per cent after very slight aperiodic fluctuations. During the periods when the plant covered the whole power requirements of the Escher Wyss Works independent from the network, the frequency remained practically constant in spite of large fluctuations in load. During considerable and sudden loading by a few hundred kilowatts the speed did not vary by more than 1 per cent. The behavior of the governing gear, which incidentally could be further improved in new plant, was very satisfactory in that it entirely coincided with the relative theoretical expectations.

[3] Editor's Note—This regulating gear and accumulator are not mentioned elsewhere in this report. They are described in some detail, however, in the Escher Wyss News, 1942-43. Their function is to regulate the machine output by regulating the density of the air in the working circuit. To do this, a centrifugal speed governor operates by-pass valves in the air compressor circuit to cause air to flow from or into a high-pressure and low-pressure accumulator system according to the load. When plant load increases, tending to decrease machine and governor speed, the governor operates the valves to cause air to flow into the air compressor circuit from the high-pressure accumulator. This increases the pressure ratios and the quantity of working medium in the circuit and decreases the volume of delivery of the compressor, thus increasing the turbine output and restoring the speed to normal. When plant load decreases, the reverse operation occurs, air flowing into the low-pressure accumulator and decreasing turbine output. The entire regulating system operates as a separate unit without interconnection of elements in the air circuits of turbines and compressors and comes in contact only with cold air.

The operation of the machines and apparatus was entirely satisfactory throughout the tests at temperatures up to about 1300 F at the inlet of the turbine and a maximum pressure of 340 psi.

The technical data of the test department prove that these results represent the fruits of systematic, scientific development, which likewise provides the necessary basis for the calculation and construction of new plants of any required output or for widely differing uses.

The possibility of burning any fuel, which will doubtless involve further important modifications to the air heater, makes the production of electrical energy a primary field for such plants. Such large installations in which an efficiency of approximately 35 per cent could be attained as the maximum figure and with only slight deterioration at part-loads, represent an enormous improvement. The cooling water consumption is only a fraction (1/3 to 1/5) that of a steam power plant, which offers much greater freedom in the choice of the site. Consequently these plants are far more independent from suitable water supplies.

The turbines are small and simple, without stop valves or regulating valves, and at all loads always operate with the same temperatures and without the danger of erosion or corrosion taking place. Steam boilers are replaced by air heaters which do not require more space—often less—and furthermore do not involve expenses for the preparation of feed water and means for preventing corrosion. The air accumulator for regulating purposes and the heat exchanger do not require any attendance. Operation of the plant promises to be extremely simple.

Conclusions

The best efficiency of a steam power plant was measured at Port Washington in the United States of America, where with a machine output of 80,000-kw an efficiency including auxiliaries of 31.7 per cent was ascertained at the coupling, but only with the adoption of intermediate heating. If intermediate heating were adopted in an Escher Wyss AK-plant of 80,000-kw output, an efficiency lying considerably above 35 per cent could, according to the present progress, be expected.

Thus the Escher Wyss AK-installation represents a thermal power plant which, with the adoption of coal firing, will permit of efficiencies being attained such as were hitherto the exclusive field of internal combustion engines, which cannot be operated with coal—the cheap fuel—and furthermore are only suitable for limited unit outputs.

Heat Balance of Plant

In a discussion of the paper, S. A. Tucker, associate editor of Power and member of the Gas Turbine Co-ordinating Committee, pointed out that the closed-cycle prime mover of 2000-kw on which the tests were made differs from open-cycle machines of the Brown Boveri type in that the equivalent of the steam-plant "boiler" and "condenser" are included. On the successful design and construction of these elements of the closed-cycle unit, he said, depends the eventual acceptability of such machines to power-plant operators in the future. These added elements offer a different approach to the problem of burning pulverized coal as well as the possibility of constructing large machines for central station application.

Mr. Tucker calculated an approximate heat balance showing probable distribution of the various heat quantities.

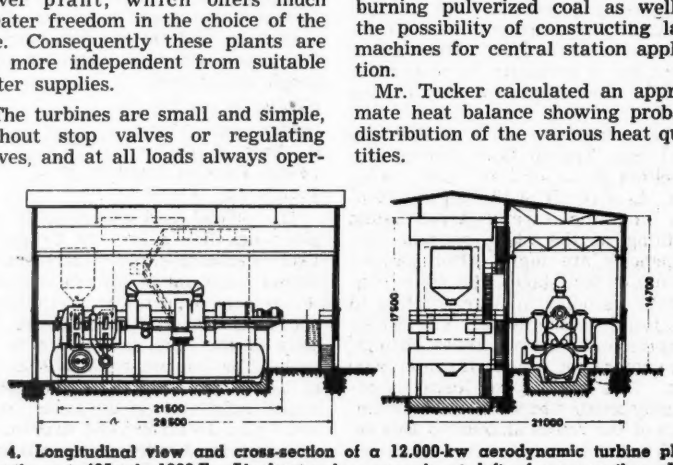


Fig. 4. Longitudinal view and cross-section of a 12,000-kw aerodynamic turbine plant, operating at 425-psi, 1200-F. Air heater in open air at left of cross-section. Heat exchanger underneath machine

The Coal-Burning Gas Turbine
for Locomotive Use

Simple, open-cycle 3000-hp gas turbine unit, burning pulverized coal, to be investigated . . . Unit with overall thermal efficiency of 15 to 20 per cent at 1000-1200 F promises simplicity of design and operation for locomotive service . . . Requires no water . . . New method of handling and pulverizing coal with coal atomizer . . . Studies to be made of combustion chamber combined with fly-ash collector

Based on an interview by CHESTER R. EARLE, Associate Editor, Power Plant Engineering with

John I. Yellott — *Director of Research, Locomotive Development Committee*

ONE OF THE FIRST projects to be investigated for immediate development by the recently-formed Locomotive Development Committee of Bituminous Coal Research, Inc., is a 3000-hp coal-burning gas turbine for driving locomotives. Under the chairmanship of R. B. White, president of the Baltimore & Ohio Railroad, the Locomotive Development Committee has been formed by six of the country's leading railroads: Baltimore & Ohio, Chesapeake & Ohio, Louisville & Nashville, New York Central, Norfolk & Western and Pennsylvania, together with the M. A. Hanna Co., Sinclair Coal Co., and Island Creek Coal Co. The committee will work in co-operation with existing research institutions to conduct research for developing a coal burning locomotive of greatly increased availability over the present design of steam locomotive and with the highest attainable overall operating efficiency. The objective, of course, is to provide a means for the increased use of bituminous coal as a locomotive fuel, thus conserving oil and providing necessary production of coal tonnage, traffic for railroads and lake carriers and continued employment in these and kindred industries.

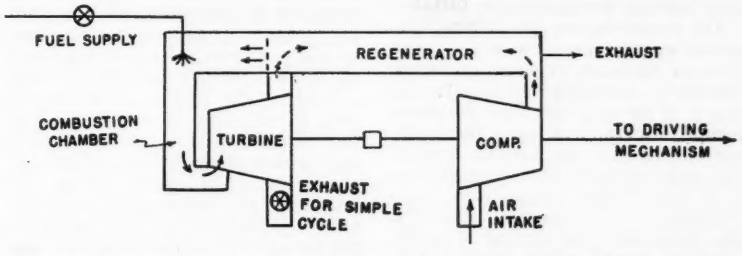


Fig. 1. Open cycle gas turbine to be investigated for locomotive drive. Extent of regenerator surface to be determined by cost and space limitations

Considerable study has been made of the possibilities of firing methods such as burning synthetic oils, use of gasifiers or various forms of gas producer, pulverized coal and stokers. Prime movers analyzed are the reciprocating steam engine, the Diesel engine, the steam turbine, the mercury-steam turbine, the open cycle gas turbine and the closed cycle gas turbine, with various electrical and mechanical methods of transmitting the prime mover power to the wheels.

As a result of these analyses, it has been decided that the coal-burning gas turbine locomotive offers the most promising line of research. Consideration will also be given to the development of a pulverized-coal-fired steam switching engine to have high availability, require refueling only once a week instead of once a day and have very low standing losses.

Decision to concentrate on the gas-turbine development was influenced by several factors. Several railroads are building a pulverized-coal-burning steam turbine electric drive locomotive. The Pennsylvania Railroad has in service a conventional freight locomotive[1] powered by direct connected geared steam turbine, burning coal; others are considering variations of it.

[1] A New Steam Turbine Locomotive; Power Plant Engineering, April, 1945.

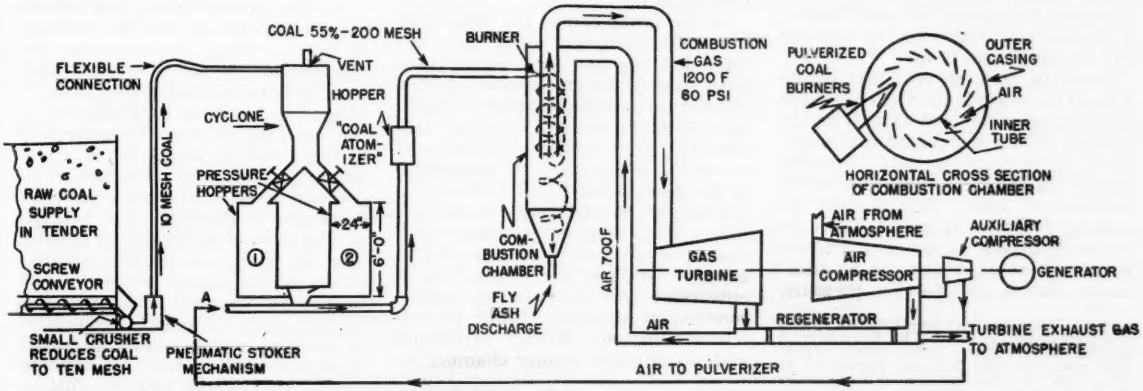


Fig. 2. Schematic diagram of the elements of the locomotive gas turbine plant, showing general principle of pulverizing and burning coal. In the actual locomotive, the various units need not be in line as shown but can be arranged more compactly

The U. S. Bureau of Mines and the oil companies are investigating development of synthetic fuels. If they become feasible, existing firing equipment can be adapted to them. Conventional producer gas equipment is too large for locomotives; to compress this equipment requires much further investigation.

The simple open-cycle gas turbine, operating at inlet gas pressures of 60-80 psi absolute and temperatures of 1000-1200 F has a thermal efficiency[2] of 20 to 25 per cent, including losses in both turbine and compressor. This efficiency is much higher than that attainable by the best noncondensing steam cycle, and comparable with efficiencies reached by moderately large stationary plants. Furthermore, the open-cycle gas turbine needs no water whatsoever. Turbine manufacturers are confident that inlet gas temperatures of 1200 F are now feasible for open-cycle turbines.

The Brown-Boveri gas turbine locomotive now in operation on the Swiss Federal Railways gives an operating efficiency, including transmission losses, of about 15 per cent. Improvements in metallurgy since the building of this first gas turbine locomotive point towards the successful use of a 1200-F inlet temperature, with attendant higher thermal efficiency. The open-cycle gas turbine is an extremely simple prime mover; compressors, turbines and regenerators are already available; and the conventional electric drive has proved its reliability over many years of service. Hence, the major problem in adapting the gas turbine to American locomotives is to make it burn bituminous coal. A simple "coal atomizer" has recently been developed,[3] and its use may greatly simplify the application of pulverized coal to the gas turbine.

Tentative Gas Turbine Locomotive Design

A tentative design for pulverized coal burning equipment for the gas turbine locomotive is shown in Fig. 2. Raw coal is transported from the tender by a screw conveyor to a small crusher, which reduces it to 10-mesh. From this crusher a standard pneumatic stoker mechanism, already available, transports the coal through a flexible connection to the locomotive or power car proper.

Here the 10-mesh coal first enters a small receiving hopper. Because the pulverizing of the coal as well as the burning of it in the combustion chamber is to be under pressure, it seems logical to put the raw coal under pressure at once. This is done by causing it to flow by gravity from the receiving hopper to the two pressure hoppers, 1 and 2, which can be alternately opened and closed to pressure, by manual or automatic operation of the interlocked valves shown during loading and discharge.

While one hopper is opened to atmospheric pressure the other is put under a pressure of about 60 + x psi, x representing transmission losses still to be determined. From it the coal, still 10 mesh in size, flows through the check valve and is transported by air pressure to the "atomizer." On the hopper being loaded with coal under atmospheric pressure, the check valve will close against the pressure in the air line A. The air transports the coal to the "coal atomizer" as shown, where it is pulverized to about 55 per cent through 200-mesh in one pass.

Pulverizing the Coal

This "atomizer" has been developed and successfully operated on steam, and the principal problem in its operation now to be investigated is the transport of raw coal from the pressure hopper by air and the effectiveness of pulverization with compressed air in the atomizer instead of steam.

Because the fuel is to be burned with a maximum of excess air (400 to 600 per cent) in the gas turbine combustion chamber instead of with the minimum of excess air as in a pulverized coal furnace, extreme fineness of pulverization is not an essential factor in combustion in this case.

However, the big problem here is to secure as little fly-ash as possible to carry over into the blades of the gas turbine. For this reason, an effort will be made to combine the combustion chamber with an efficient cyclone dust separator. In addition, a secondary separator may be installed between the combustion chamber and the turbine.

Combustion Chamber Design

The combustion chamber will be designed as shown in Fig. 2, along lines already shown to be feasible.[4] One or more coal burners will be set around the top to produce a tangential flame, while hot air from the air compressor and regenerator will be introduced tangentially to form a whirling flame spiraling downward about the inner tube of the combustion chamber.

At the lower end of the inner tube the combustion gases will turn upward 180 deg and pass through the inner tube to the gas turbine. At this 180-deg turn of the combustion gases, most of the fly-ash will drop out. This operation also must be investigated to determine the resulting cleanliness of the gases going to the turbine.

With 400-600 per cent excess air, rather than with the minimum possible excess air, which is the goal in a boiler furnace, the combustion of pulverized coal particles in such a combustion chamber should be virtually complete. British experience with a somewhat similar chamber indicates that a heat release of 500,000 Btu per hour per cubic foot can be obtained with pulverized coal at atmospheric pressure. With the elevated pressure which will be used, this rate should be considerably increased. The major problem, therefore, is the removal of the maximum possible amount of the fly-ash.

From the combustion chamber, the gases pass to a conventional gas turbine, equipped with a single regenerator. The size and capacity of the regenerator must be determined with due regard to space limitation, cost, and thermal efficiency. For locomotive use, reliability is more important than maximum thermal efficiency, and so the simple cycle has been selected. However, the use of a somewhat more complicated cycle will enable higher pressures to be used, hence a smaller combustion chamber.

The question of the emission of fly-ash from the exhaust should not be serious, because it is essential that the maximum possible removal of fly-ash be obtained before the combustion gases enter the turbine. A possible use for the collected fly-ash may be found in sanding the rails. There will be no smoke from the coal burning gas turbine, because of the turbulence and excess air which will be present in the combustion chamber.

When the combustion and ash removal problems are solved, the gas turbine locomotive will be extremely simple to operate, and will require a minimum of servicing. The only water needed on the locomotive will be that for the train heating boiler, which may well be electrical because of the increased efficiency enjoyed by the gas turbine when winter lowers the inlet air temperature.

Direct current electrical drive of the type now in use on Diesel-electric locomotives will be applied in the first gas turbine units. However, there are advantages to be gained from the use of alternating current, and this possibility will be given careful study. Mechanical drive has been suggested, and successful development of such a drive would reduce the first cost of the locomotive, and would also improve transmission efficiency.

At the present time, the general plan is to work out first the problems of coal handling, pulverization, and combustion. Research on these problems will be carried out at Battelle Memorial Institute in Columbus, at the Institute of Gas Technology in Chicago, and at Johns Hopkins University in Baltimore. Because of the pressing need for motive power of increased availability, the research will be pushed as rapidly as possible. The aid of the gas turbine manufacturers will be sought when the combustion problem has reached a satisfactory state. Successful completion of the first coal burning gas turbine locomotive will insure the continued use of coal as the primary fuel for American railroads. It will also be of vital interest to the power world.

[2] See The Gas Turbine—Present Status and Immediate Prospects, by Soderberg & Smith, Power Plant Engineering, April, 1944; also The Gas Turbine, Especially as Compared to the Steam Turbine, by Fischer and Meyer, Ibid, May, 1944.

[3] To be described in detail in a subsequent issue.

[4] See operating results of gas turbines of Sun Oil Co., page 77, this issue. Also The Gas Turbine, Here's What the Equipment Looks Like, June, 1944, issue.

Centrifugal Pump Control*

Part VI

Technique of control application . . . Basic principles . . . Controls must have accuracy, sensitivity, speed, power . . . Selection of measuring point . . . Range of variation in controlled quantity . . . Valve construction and characteristics . . . Types of control and regulating valves . . . Selection of power medium . . . Avoid "over-engineering" . . . Control supplements, not supplants, instruments and men . . . Data you should give control manufacturer when ordering control equipment

By Igor J. Karassik **Application Engineer, Worthington Pump & Machinery Corp.**

KNOWLEDGE OF THE fundamental control functions, of the pump characteristics that these controls are intended to modify, of the component elements of controls and the understanding of some typical applications are not a sufficient guarantee of perfect handling of all control problems which may be encountered in the installation of centrifugal pump systems. There is needed, in addition, a certain familiarity with the technique of control application, a familiarity which can best be acquired through experience. This statement should not be construed, however, to mean that it is not practical to acquire some knowledge of this technique analytically.

This article, last of the series on centrifugal pump controls, is therefore intended to present to the reader some of the basic principles of the technique of control application. And because the majority of pump controls are based on throttling either the main delivery stream itself, or some part of this stream in a take-off branch, the greater portion of this article will be devoted to the application of throttling valves whether manually, automatically or semi-automatically controlled.

Every manufacturer of controls will agree that such apparatus must be endowed with the following characteristics:

1) Accuracy
2) Sensitivity
3) Speed
4) Power

These characteristics are imparted to the control apparatus by its manufacturer. Nevertheless, it must be well understood that unless the engineer applying the controls will see to it that these characteristics can be utilized, all the care that the designer may have exercised to insure for his control the possession of such characteristics will have been wasted.

Proper Measuring Point Affects Accuracy

Accuracy can only be obtained if the variable to be controlled is measured at a point in the system where a true reading can be obtained. Such precautions may sound obvious but, unfortunately, pressure or flow measurements are often attempted at such locations where the reading is definitely distorted. Measurements can also be distored if the measuring element or the piping adjacent to it is allowed to become dirty, clogged or incrusted. Thus, for instance, flow measurements by means of Venturi meter or orifice should be made at a point where the flow of liquid in the piping system has been properly straightened out. Definite recommendations are generally made by control manufacturers as to the length of straight piping required ahead of the measuring element and these should be carefully followed.

To be accurate, controls must respond to the slightest deviations from the desired value of the variable being controlled. In order to obtain such sensitivity, it is necessary to weigh the application thoroughly. For instance, if the controlling or measuring element is excessively oversize in relation to the quantity to be measured, all sensitivity is lost. In some cases where the range of operating conditions varies within wide margins and where sensitivity is required under all conditions, it may be practical to split the quantity to be measured into two portions, two measuring elements integrating the total quantity for the upper range of its value and a single element used whenever the total quantity is reduced to less than one-half of its maximum value.

In general it is preferable, although not always practical, that the greater accuracy of regulation occur in that portion of the operating range where sensitive control is most desired.

Sensitivity and Range of Variation

Flow meter control of a boiler feed pump by-pass presents a typical example of the analysis required to insure sensitivity in the proper range of the quantity being measured. This control is intended to open the by-pass valve whenever the feed pump flow falls to dangerously low values. The impulse used to operate the control consists of the differential pressure across a metering orifice and, obviously, this differential is highest at the maximum flows and lowest in that particular range where it must operate the by-pass control. The size of the metering orifice must, there-

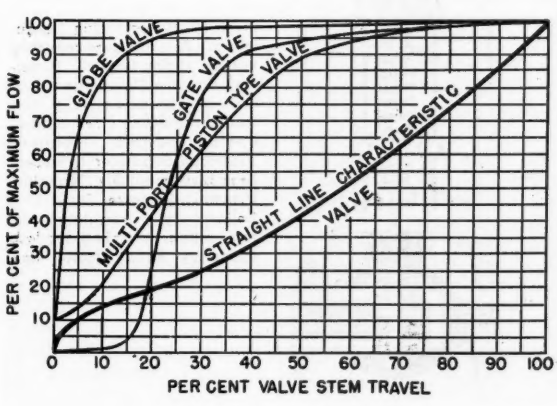


Fig. 1. Characteristics of flow curves for various types of valves. (Courtesy Bailey Meter Co.)

All rights of re-publication reserved by the author.

*This is the final article in a series of six by Mr. Karassik, all under the general title, Centrifugal Pump Control, appearing in POWER PLANT ENGINEERING in the following order: Part I, Characteristics of Centrifugal Pumps, December, 1944; Part II, Functions of Centrifugal Pump Control, January, 1945; Part III, Analysis of Control Elements, February, 1945; Part IV, Analysis of Boiler Feed Pump Control, March, 1945; Part V, Protective Controls, June, 1945; Part VI, herewith.

fore, be selected to compromise between two contradictory requirements:

1) The differential at low flows must be sufficient to provide sensitivity in the by-pass operating range.
2) The differential at maximum flows must not be excessive, lest the resulting head loss become an unwelcome factor in the boiler feed pump installation.

This differential, of course, varies as the square of the feedwater flow and, while in some cases a suitable compromise may be reached, the obvious solution lies in so locating the orifice that excessive differentials at high flows will not prove embarrassing. This explains the frequent recommendation to place the orifice in the boiler feed pump discharge rather than in the suction piping where the resulting head loss will rob the pump of an appreciable portion of the available net positive suction head.

Effect of Valve Size

Sensitivity is an attribute of corrective pump controls which is affected by valve size as much if not more than by the proper selection of the measuring element. Valve manufacturers frequently call attention to the fact that the proportions and contours of the fluid passages must be given special attention, in order to avoid excessively turbulent flow and ensuing erosion. This phase of the control problem belongs in a treatise on valve design rather than on the application of controls to centrifugal pumps. The relation between the valve lift, the area of the opening and the resulting flow, however, do play an important part in the successful application of valves.

If the valve size selected is too small for the range of capacities encountered, the friction losses will be higher than necessary and valve wear excessive. The penalty for undersized valves, therefore, is an unjustified increase in power consumption because of the increased total required head in the pumping system and in valve maintenance.

Valves Can Be Too Big

But just as a valve may be too small for its intended service, it may also be much too large. Since the area of opening of a given valve must be made commensurate with the quantity of liquid it is desired to pass through the valve, the latter would be almost closed under most operating conditions. This may lead to wire-drawing and certainly to a decrease in sensitivity.

Consider, for instance, the case of the valves illustrated in Fig. 1. If a gate valve were to be selected considerably oversize, that is if the maximum flow in the system corresponded to approximately 50 per cent of the maximum permissible flow through the valve, then the valve stem would have to be held at approximately 23 per cent of its maximum travel. A reduction of 50 per cent in demand (or to 25 per cent of the maximum flow through the valve) would call for the movement of the valve stem to a position at 20 per cent of its travel, a reduction of only 3 per cent of the total travel from its former position, corresponding to a negligible angular displacement of the control wheel. Such a situation is even further magnified in the case of a globe valve and explains the reason for the unpopularity of the latter on throttling service.

It is obvious, therefore, that to fulfill the requirements of accurate and sensitive regulation throughout the full operating range of the controlled equipment, valve design should be preferably such as to give substantially equal increments of flow for equal increments of valve stem travel, regardless of whether the valve is near the closed or open position. Such a design, generally called a "straight line characteristic valve" and illustrated in Fig. 1, is available with a great number of valve manufacturers.

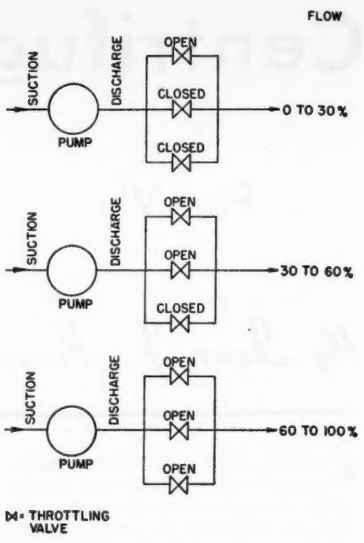


Fig. 2. How several control valves are installed in parallel to provide accurate regulation under wide range of demand

The disadvantages of valve oversizing do not, of course, apply to fixed, non-throttling valves used for on-or-off service. The only effect of oversizing in such a case is to reduce friction losses at the penalty of increasing initial costs to a point of diminishing returns.

Parallel Valves for Wide Range

Situations may arise, however, which call for the use of valves much too large for normal operating conditions and yet of the proper size when certain emergency increased flows occur. An arrangement which presents definite advantages whenever such wide variations in service demands are encountered is the use of several valves installed in parallel. In the arrangement illustrated in Fig. 2, one valve only is open at very

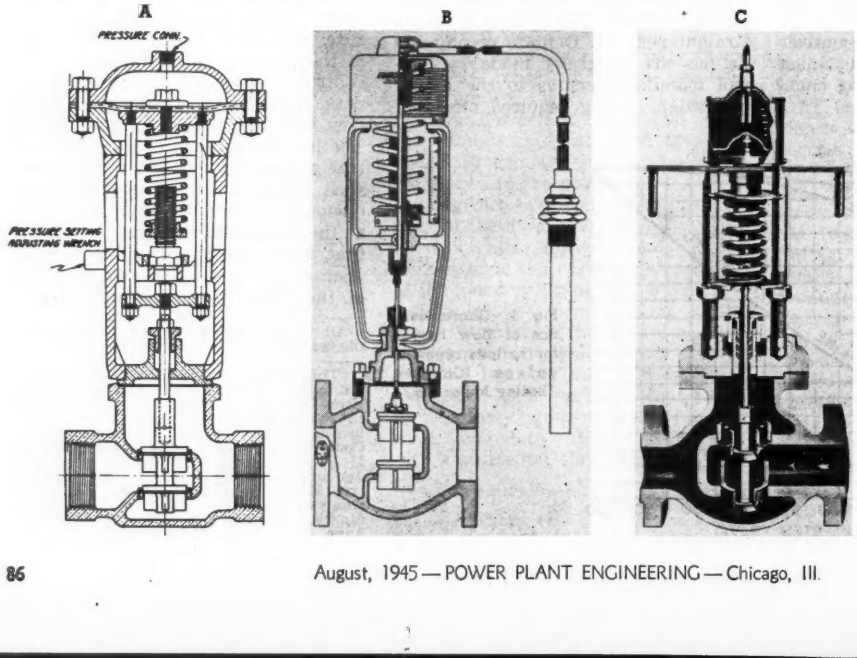


Fig. 3. Direct-acting regulators. A—Pressure-reducing valve, spring-loaded. (Courtesy Ruggles-Klingemann Mfg. Co.). B—Thermostatically controlled regulator, direct-acting, spring-loaded. (Courtesy American Schaeffer & Budenberg Instrument Div., Manning Maxwell & Morre, Inc.). C—Bellows type regulator, direct-acting, spring-loaded. (Courtesy Bailey Meter Co.)

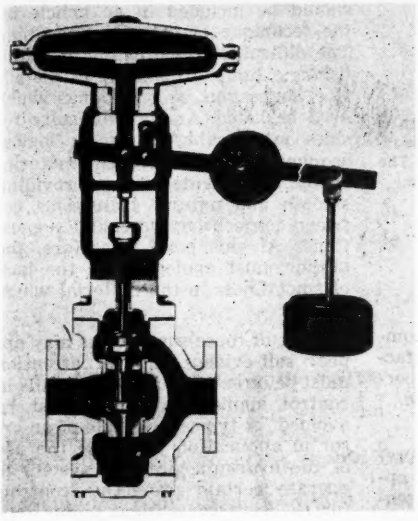


Fig. 4. Pressure reducing valve, direct-acting, weight-loaded. (Courtesy Fisher Governor Co.)

light flows, additional valves being opened when the demand is increased.

Except for those applications where the impulse is transmitted manually, speed of impulse transmission is generally the control manufacturer's problem. However, in many instances, the user may handicap the manufacturer of controls in this respect by his insistence on this or that operating medium which, under the prevailing conditions, precludes suitable speed of transmission and may introduce a time lag which ultimately defeats the entire purpose of the automatic control application.

Selecting the Right Power Element

Finally, the action of the control must be quick and positive. An analysis of the power element of the control which will prove to be most successful for a given application must be based on the understanding of the various forms of power elements available and of their respective advantages and limitations. Automatic valves and regulators can be classified into two separate groups:

1) Direct acting
and 2) Pilot operated

Direct-Acting Regulators

Direct acting regulators are operated by the pressure of the system which it is desired to control. This pressure acts directly on one side of a diaphragm, bellows or piston. The balancing force, which is set to a predetermined value, may be one or more springs, a weighted lever or a preset air pressure. They are mainly applicable where the variable to be controlled is the pressure in the system, as direct acting controls cannot be made subject to capacity variation impulses. They can also be made to control temperature changes, as the latter can provide pressure variations in liquid or gas filled bulbs and connecting tubing.

Direct acting, spring-loaded (Figs. 3a, b and c)—Single or multiple spring loading may be used, depending on the range of the controlled pressure, on the maximum valve travel and on the total pressure load acting on the diaphragm bellows or piston. It is most favored for the majority of regulators because of its inherent compactness. Such regulators however, cannot control pressures with extreme accuracy because of the variation in the compression of the loading springs between the full open and full closed positions of the valve. The application of this type of control must therefore be restricted to relatively low pressures and either narrow ranges of valve positioning or lack of need for very accurate regulation.

Direct acting, weight loaded (Fig. 4)—This type of control is very sensitive to small pressure variations and avoids the shortcomings of spring loading in that the dead weight lacks the variation of compression inherent to springs. It is, however, limited to low pressure service because of the large weights required when pressures increase and of the resulting cumbersome construction of the control.

Direct acting, air loaded (Fig. 5)—The general characteristics of an air-dome loaded control valve, as illustrated in Fig. 5 are the same as those of weight loaded controls, since a constant loading pressure may be maintained. Its main advantage resides in the elimination of impractically large and cumbersome weights and, therefore, permits its application to very wide pressure ranges. Unlike the weight loaded regulators, the air-dome control requires frequent checks of the loading pressure and may need more frequent adjustments.

It goes without saying that all three sources of loading, that is spring, weight and air pressure, can be adjusted with relative ease, by tightening or loosening the springs in one case, by varying the dead weight in the second, and by pumping up or releasing some air from the dome in the last case. The first two may be adjusted while in operation while the third generally cannot.

Pilot-Operated Controls

Pilot operated controls are preferred where the forces involved in adjusting valve positioning may be excessive for direct acting controls. A control should have sufficient reserve power to handle emergency conditions such as sticking valves, etc. In this particular case, it is well to caution users of automatic control that frequently where a direct acting control may still be practical and less expensive than a pilot operated control, the latter gives a powerful posi-

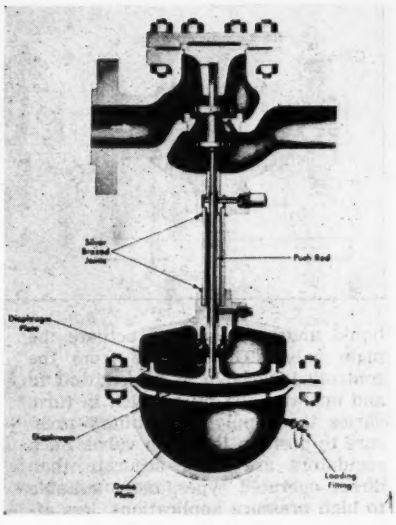


Fig. 5. Pressure reducing valve, direct-acting, air-loaded. (Courtesy Foster Engineering Co.)

tive control action which can never be obtained from a direct acting regulator.

Internal pilot operating regulators (Fig. 6)—Just as in the case of direct acting controls, internal pilot operated regulators are only applicable to maintain pressure relations in a pumping system. The pilot is built into the main valve and is operated by the controlled pressure while the main valve is actuated by the initial pressure upstream of the control. Such units are self-contained and compact, requiring no external operating pressure supply and are therefore unaffected by any possible failure of such supply.

External pilot operated regulators (Fig. 7)—This type of control requires an external supply of auxiliary air, non-corrosive gas, water, oil or other

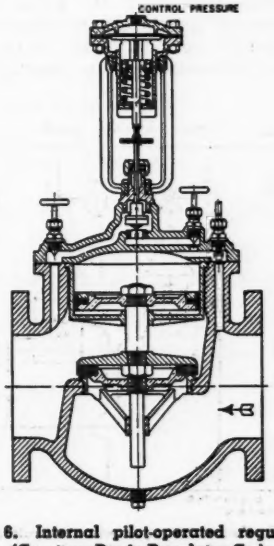


Fig. 6. Internal pilot-operated regulator. (Courtesy Davis Regulator Co.)

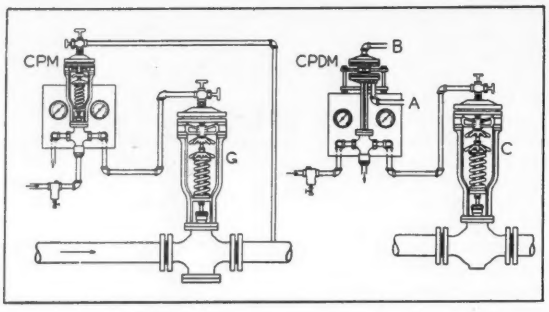


Fig. 7. External pilot-operated regulator. (Courtesy The Swartwout Co.)

liquid under pressure to actuate the main valve. The impulse from the controlled variable is transmitted to and operates the pilot which in turn, varies the supply of auxiliary pressure to position the main valve. Such regulators are more accurate than direct operated types, more suitable to high pressure applications, less affected by wide variations in the controlled variable and more easily and precisely adjustable. In a great many cases the pilot may be located elsewhere than at the controlling valve for greater convenience of the installation. But most important of all, external pilot operated regulators are applicable to capacity as well as to pressure control, since the pilot may become actuated by variations of differential pressure across a flow measuring mechanism.

Power Element for External Pilot-Operated Pump Controls

The selection of the medium for the power element of external pilot operated centrifugal pump controls merits very special consideration. Controls operated by a liquid have a somewhat slower response to controlled variable changes than the air or gas operated types but are particularly valuable where very large main valves are used and where the power required to operate them is made more readily available from hydraulic pressure than from the usual compressed air system. At the same time, reliability considerations must be given full weight in the selection of the power medium and the recommendations of the control manufacturer trusted more than a merely personal preference or even prejudice.

Electrically-Operated Controls

Nothing has been said in the preceding paragraphs of electrically operated valve controls. These are generally available either in the semi-automatic or in the fully automatic types. In both cases, an electrically operated valve consists of a reversing torque motor driving the valve stem through a train of gears. The motor control is arranged to stop the valve in a full closed or full open position as well as in any intermediate position which may be required to obtain the desired control.

In the case of semi-automatic operation, the impulse is manual and controlled by the operator at a push-button station. In a large installation, requiring the manipulation of a great number of valves, full control of each valve can be provided in a centrally located battery of push-buttons. Such control permits to install the valves where best plant design and not accessibility considerations dictate. When full automatic operation is required, the measuring element is made to transmit the necessary impulse to the control panel where, in turn, an electric circuit is made and operates the main valve motor in the desired direction.

Paradoxically enough, one of the most difficult variables to control is the extent of the material which should be included in an article on the technique of control application. The difficulty arises mainly in establishing a limit to the scope of the advice, suggestions and warnings which need be listed. Another difficulty resides in selecting the most logical sequence in which such material should be presented and in providing smooth and natural transitions between consecutive individual suggestions. At this point, therefore, the author must apologize for the lack of smoothness in the material which follows.

Some of these suggestions may appear self-evident and yet attention must be directed to certain pitfalls in control application which must be avoided. A typical example of an error in application would be the use of the hydraulic pressure system to operate certain protective controls for the very centrifugal pump activating this system. If the function performed by the protective control is not necessary, should the pump be suddenly stopped, the use of the system pressure for the power element of the control is acceptable, at least from the point of view of the safety of the supply. If, on the other hand, the protective control is required to function either on the stoppage of the pump or even during the starting and stopping period, such an application is absolutely unthinkable.

Avoid Over-Engineering

Another typical warning is that there is in control selection, as in the selection of any other equipment, a tendency towards "over-engineering." This refers to the selection of equipment which is actually too good for the intended job, of controls which are designed to perform a more difficult function than required in the given instance. This leads to unnecessary expense and, at times, to excessive outage and maintenance which could easily be avoided by the application of less complex mechanisms.

Logical Solution Not Always the Most Practical

Sometimes the most logical solution of a control problem does not

(Continued on page 122)

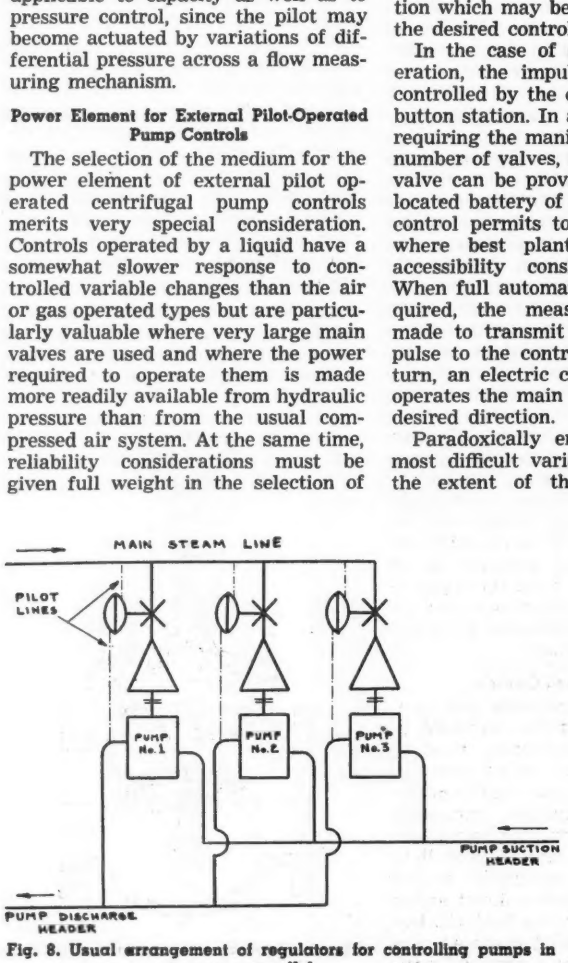


Fig. 8. Usual arrangement of regulators for controlling pumps in parallel

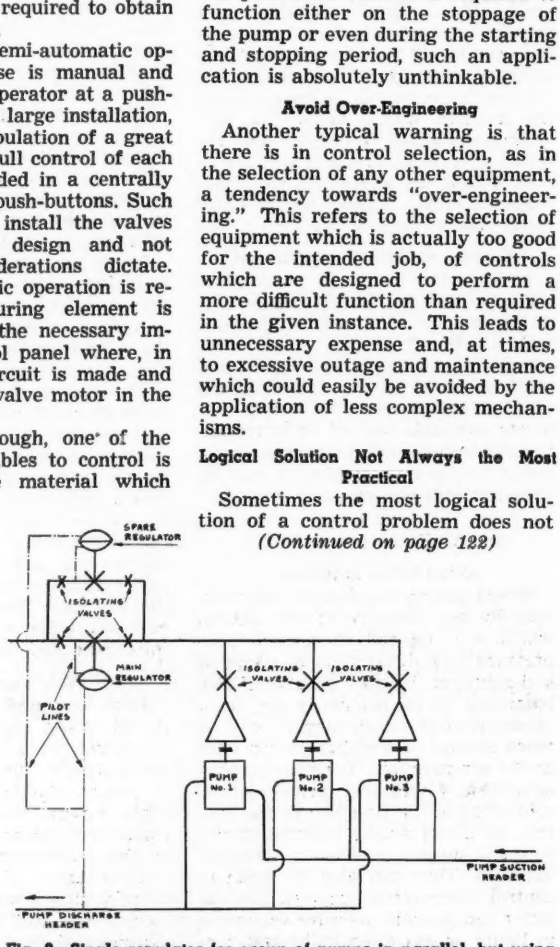


Fig. 9. Single regulator for group of pumps in parallel, but using too many valves, and not so practical as Fig. 8

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Parker's S O S in Verse

What would you do if you were me
And had a hole, or two or three
Where, definitely, no holes should be?

It seems my coils are shot to bits;
They've undergone an awful blitz;
They're just about to call it quits.

Solder? Wasn't worth a damn.
Clamps? They took it on the lam.
Discouraged? Yes, by gosh, I am.

Honestly, its pretty rank
To hear the rattle and the clank
In that cussed water tank.

I've raised my steam, oh, much too much!
My lowered water pressure's such
That with Docs and Nurses I'm in Dutch.

You've often helped me heretofore,
And though it may seem like a chore
I'm sure you'll "do your stuff" some more.

Dismounting from an indubitably spavined Pegasus, my hot water tank coils are shot. The only way I can continue its use is to raise my steam pressure to 40 psi and lower the water pressure to 30 psi. Actually, except for disturbance when steam blows out of the coils into the water, the tank never delivered so much hot water for so little steam. It may be a long time before we can get repairs. Can it do any harm to let things go on as they are now going. My drips are closed tight and every bit of the heat in the steam is used as well as all condensate.

that D——Parker again.*

P. S.—

My boss opines there's one thing worse
Than my engineering—that's my verse.
I think with rhymes I'm sort of handy.
That's my opinion. What's yours, Andy?

*Nobody else but our old friend Arthur Parker of The Peterborough (N. H.) Hospital.

CONTENTS

The Mystery of the Rasping Compressor 90
By George Holman

Comments on Lubrication, Also on Freezing of Water 91
By Henry D. Norris

Record System in Power Plant Improves Operation 92
By John F. Slavinsky

Thermal Properties of Water 93

Practical Hints and Kinks 93
Porcelain Sockets
Multiple Height Gage
Special Arbor for Accurate Grinding

The Boiler Fireman's Handbook 94
By J. R. Darnell

The Fundamentals of Electron Tubes 96
By Ralph B. Immel

The Strange Case of the Capacitor Motor 98

Fire Protection for Electrical Apparatus 99

It's Dangerous to Wear Overalls 99

Logarithms Without Interpolation 100

Questions and Answers 102
What Hp Will This Engine Develop?
How About a Corliss with Three Eccentrics?
How Control Village Water System from Pressure?
How Calculate Efficiency of This 2500-kw Turbine?
Why Is Water Level Hard to Control?
What Do You Do About Feed Pump Corrosion?
Why Is Barometric Condenser Water Backing Up?
How Make High-Pressure Steam Out of Low-Pressure Steam?
What Type of Boilers and Stokers Should They Choose?
What Sucks the Water Out of the Bucket?

Chart for Determining Expected Fluorescent Lamp Replacements Per Month 112

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

The Mystery of the Rasping Compressor

By GEORGE HOLMAN

Here is a first class refrigeration mystery. It is the story of an otherwise perfectly normal ammonia compressor that indulged in letting out the most unearthly racket you can imagine. It did not do it all the time, only when it felt like it. Then it rasped and scratched and clattered in the most awful manner. It nearly drove the operators nuts. Nothing they could do would stop it. The more they took the machine apart the less they found and in the meantime the machine performed perfectly in every other way—except for the noise. And then, one fine day, Dumb Bill, the ice harvester—but wait a minute, we don't want to tell the story here; read it yourself and learn a good lesson from it.

As RAY, our day engineer, expressed it, one of our high speed ammonia compressors got the "buck aguer." The trouble began about mid-morning of the first hot and humid day of the season. I was engineer in charge at the time, stood an 8-hour shift from 4:00 pm to midnight, and did most of the maintenance. Frequently I dropped into the plant in mid-morning just to look things over. This was nine years ago.

This particular morning I found Ray standing beside the idle compressor. Water dripping from the suction manifold told me he had just shut down the compressor. To my question as to what was wrong Ray replied: "It sounded like a broke ring was cuttin' the livin' h—l out of the cylinder linin'."

Beads of sweat outside the cylinders showed that they had not been hot, and that compression had been wet or saturated. No place on the machine was warmer than usual. I closed the discharge valve and opened the by-pass valve. This took the head pressure off the pistons. By climbing the spokes of the flywheel-pulley, we turned the machine over several revolutions by hand—or rather by foot. It turned easily. There was no grating or rasping or other unusual sound, such as Ray described. "Let's hear her run," I told him.

Ray closed the switch. Off she went, as smoothly as any machine that ever operated. We ran on a constant quantity of water recirculated over a cooling tower, and the discharge pressure climbed to 190 psi. Ray watched it climb, commented that it had reached 200 psi before he shut the compressor down, then went about his work.

When I entered the plant at 10:00 am next day, Ray was again standing beside the idle compressor. "That funny noise started ag'in this mornin'," he said, with an apologetic grin. "I was goin' to let it run till you showed up. But I couldn't take it. Ask Bill. He heard it, too."

Bill, our ice harvester, said: "I don't know much about machinery. But she sounded like a ripsaw cuttin' through nails."

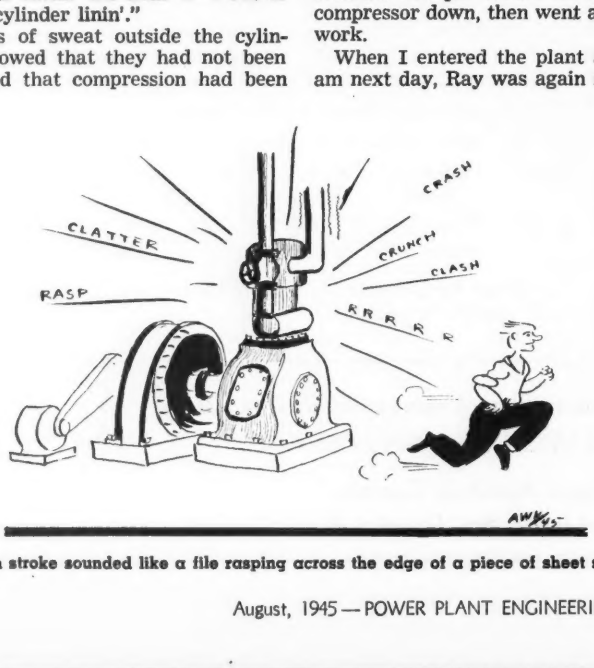
I hated to go into that compressor. We always overhauled all machines yearly, and expected every one of them to make the season's run without a forced shutdown. But two men had heard the noise. At least a superficial inspection was necessary. We took off the heads, lifted out the safety heads and without waiting for the ammonia to clear, batted our eyes, held our breath and peered into the cylinders. By the light of the lamp on our drop cord, glassy smooth cylinder walls sent sparkling little diamonds beaming back at us. I had never seen or felt a smoother finish inside any cylinder.

We made a hasty inspection of the poppet type suction and discharge valves. Without opening the crankcase, we reassembled the compressor. The brine temperature was climbing fast, and we couldn't keep the machine off much longer. We started carefully, and for a time kept the suction pressure low. Again the discharge pressure rose to 190 psi. The compressor ran smoothly. Ray looked baffled. "I still say there's somethin' wrong," he insisted.

It rained that night to break a short heat wave. Several cool days followed, during which the head pressure never climbed above 160 psi. I razzed Ray unmercifully about scraping out the compressor cylinders. He took it with his usual good humor, but a bit ruefully.

But on the morning of the first full day of the second heat wave Ray was waiting for me at the door of the plant. His grin was broader than usual. My ears told me the reason. The compressor sounded more like a gardener filing his hoe than an efficient part of a refrigeration system. Each stroke was like the stroke of a file over the edge of sheet steel. It set my teeth on edge. Before Ray could speak I sprinted to the switchboard and shut down the compressor. I'd have sworn it was full of sand or emery dust.

As a holding operation we put the brine cooler on another compressor through cross-over valves. Then piece by piece we dismantled the affected compressor. From oil pump to safety heads and back to piston rings and crank bearings, we looked each piece over minutely. There were no signs whatever of anything wrong. All rubbing surfaces were clean and well oiled. We steamed out the oil filter and gas strainer, then washed them in gasoline. We renewed the oil wicks in a capillary lubricator, and ran wires through the tubes leading to the cyl-



Each stroke sounded like a file rasping across the edge of a piece of sheet steel

inder walls. Tired, hot and hungry, we started the compressor just eight hours later. It ran smoothly and well, and when I went off shift at midnight, I wouldn't have traded it for any compressor of like capacity.

Ray was standing in the doorway when I turned the corner next morning. His unusually broad grin disappeared into uproarious laughter as he saw by my expression that I had heard the compressor at it again. As I charged him, he dashed for the safety of the tank room. "So you're an A-No. 1 mechanic!" he booed through a crack in the door.

I had no time for his nonsense. With my hands over my ears and with a piece of hardwood between my teeth for a stethescope, I listened to that compressor misbehave. Had the pistons been of emery stone, they could not have sounded more like they were grinding out the insides of the cylinders. Yet the two inspections were ample proof that the cylinder walls were in excellent condition.

For a month Ray and I searched for the cause of that irritating noise. We gathered a surprising amount of data on it. For example, it occurred only on hot days when the discharge pressure rose above 190 psi, but ceased if the pressure rose above 205 psi. Suction pressure had to be above 22 psi for this strange noise to appear. And suction gas had to be wet, saturated or containing very little superheat.

With all our data, we got nowhere. It was Bill, the ice harvester—Dumb Bill, we sometimes called him—who literally put his finger on it. To repay us for occasionally helping him with his harder work, he sometimes wiped the machines. One day when the compressor was grinding away, he called me. "Listen," he said, and put his finger on one of the oil tubes. The noise promptly stopped, only to start again the instant he took his finger away. The noise was nothing more than this tube vibrating when a specific tempo was reached by the compressor. The mystery was solved.

Comments on Lubrication, Also on Freezing of Water

By Henry D. Norris

I have been reading POWER PLANT ENGINEERING for some time, since I am interested in turbine oils and lubrication of turbines. For the past two years I have been synthesizing turbine oil additives; both antirust agents and antioxidants, and as a result have learned quite a bit about turbine oils. However, many of the aspects of turbine operation are very vague in my mind, and I have enjoyed the articles on turbine operation very much. I would like to see an article on turbine lubrication from the operators' standpoint, i.e., such information as to the amount and type of water in turbine lubrication systems, problems discussed as to how this water may be removed, what is desirable in a good turbine lubricant, etc. This type of an article would be of great interest to all who are interested in the production of better grade turbine lubricants.

I generally look over your problem section every month, usually the problems are out of my line and I can do no more than wait for somebody to come along with the right answer. However, I did a little literature work on the problem in the November, 1944, issue on the P. T. relationship of the freezing point of water. I don't think the answers published so far have been quite sufficient for a clear explanation of the problem. So I'll offer my two cents worth.

A. The first assumption to be made is that the container be strong enough to have a constant volume. It is quite possible to build such a container.

B. Then if the volume is constant there can only be two variables, i.e., pressure and temperature.

C. (Bridgman, 1912) published the first comprehensive paper on the P.T. relationship of water, ice. Bridgman's work along with most of the other workers has been compiled in the International Critical Tables. The important facts are:

1. There are five forms of ice. They are designated by Roman numerals, I, II, III, V, VI. Each has its own physical properties.

2. As the temperature is lowered the pressure increases until at —22.1 C, and somewhat above 2100 atmospheres pressure a form of ice is formed, Number VI, which has a specific gravity of less than 1.000 so that the pressure will no longer increase with further cooling.

Therefore it is seen that a form of ice, VI, is formed with a density of less than one which allows the liquid to solidify in a container that does not necessarily have to change in volume.

This information is also available in almost any comprehensive book on Physical Chemistry. Obviously the engineers who read your publication are not physical chemists, and it makes me feel a little better to occasionally solve one of the problems.

"Never did I realize before that steam engines could be so much fun!"

Record System in Power Plant Improves Operation

By John F. Slavinsky

SINCE OPERATING engineers are usually interested in the way things are done in other plants, the following account of the methods used in our plant and the system of keeping operating records may be of value to other readers of POWER PLANT ENGINEERING.

This plant is a typical medium sized industrial plant, in which the principal equipment consists of a new 60,000 lb per hr boiler, two turbo-generator units and one Skinner Unaflow engine driving a 1000 amp d-c generator. After the new 60,000 lb per hr steam generator was installed, we decided to do away with the old engine-room log sheet which had been in use for many years. A careful study of our operating problems finally led us to work out a system for keeping daily operating records by using two separate log sheets—one, a boiler room record and the other an electric generating record which is kept in the turbine room.

The readings of the different instruments are taken every two hours by the operators, although the watch engineer makes the feedwater tests, the results are entered on the boiler room record because that is where this data belongs. Each man on watch has an opportunity to make a report on what repairs may be needed. These, of course, are checked by the chief engineer, and if the latter feels that they are necessary he puts them on the week end work sheet.

The manufacturing process at this plant requires 24 hr, round-the-clock operation, so we have certain routine tasks to perform on the regular week end shut down.

Each shift is required to do its share of the maintenance work and the routine jobs that are listed on the work sheet. The man on a particular shift does the work assigned to that shift and signs his name in the "completed" column. This avoids buck passing when the work is not completed by the man whose turn it is to do the work. As the shifts rotate from week to week, each man gets a chance at the work.

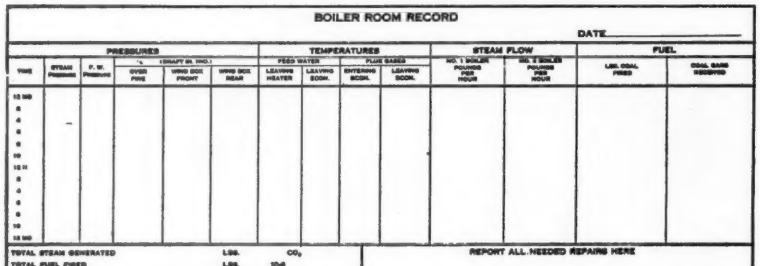
Any additional repairs to be made are marked down in the blank spaces provided, with ink and the chief engineer assigns that particular job to the man whom he feels is best qualified to do that type of repair. We have had this system in effect since 1941 and so far it has given entire satisfaction.

It may be noted that there are two work sheets, one for the boiler room and one for the engine room. The boiler room force does its own work unless it happens that some part of the mechanical equipment needs servicing, then the watch engineer is assigned to do the work with the help of one of the boiler room men. This gives the boiler room men an opportunity to learn how certain jobs are done and gives the engineer a chance to explain, step by step, just what is being done and why.

Another thing that we have inaugurated in this plant is a promotion system whereby a person who is interested in becoming an engineer is given every opportunity to do so. By helping the engineer on these various jobs he learns a great deal.

When the person is interested enough in engineering to want to obtain, say, a third grade engineer's license, we give him as much instruction as time permits and when the time comes when an engineer is needed this man is ready for the job.

In addition to the main generating equipment listed, we also operate a motor generator, two air compressors and, of course, the usual auxiliaries found in every power plant.


BOILER ROOM RECORD

DATE

PRESSURES | TEMPERATURES | STEAM FLOW | FUEL

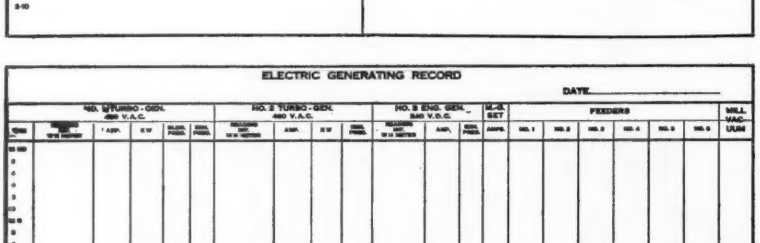
TIME | STEAM PRESSURE | F. W. PRESSURE | "A" DRAFT IN. H2O: OVER FIRE | WING BOX FRONT | WING BOX REAR | FEED WATER: LEAVING HEATER | LEAVING ECON. | FLUE GASES: ENTERING ECON. | LEAVING ECON. | NO. 1 BOILER POUNDS PER HOUR | NO. 2 BOILER POUNDS PER HOUR | LBS. COAL FIRED | COAL GAGE READING

12 MID
6
4
6
8
10
12 N
2
4
6
8
10
12 MID

TOTAL STEAM GENERATED LBS. CO_2
TOTAL FUEL FIRED LBS. 10-6
ACTUAL EVAP. LBS. 8-2
BOILER WATER TESTS 2-10
ALKALINITY SULPHATE CONC.
CHLORIDE PHOSPHATE
OXYGEN SANTOSITE

OPERATORS
10-6
8-2
2-10

REPORT ALL NEEDED REPAIRS HERE


ELECTRIC GENERATING RECORD

DATE

NO. 1 TURBO-GEN. 480 V.A.C. | NO. 2 TURBO-GEN. 480 V.A.C. | NO. 3 ENG. GEN. 240 V.D.C. | M.-S. SET | FEEDERS | MILL VAC

TIME | READING ON K.W. METER | AMP. | K.W. | BLDG. FIELD | GEN. FIELD | READING ON K.W. METER | AMP. | K.W. | GEN. FIELD | READING ON K.W. METER | AMP. | BLDG. FIELD | GEN. FIELD | AMPS. | NO. 1 | NO. 2 | NO. 3 | NO. 4 | NO. 5 | NO. 6 | UNIT

12 MID
2
4
6
8
10
12 N
2
4
6
8
10
12 MID

TOTAL A.C. GEN. K.W.H.
TOTAL D.C. GEN. K.W.H.
TOTAL A.C. & D.C. GEN. K.W.H.
K.W.H. PER LB. FUEL K.W.H.

OPERATING ENGINEERS
10-6
8-2
2-10

REPORT ALL REPAIRS NEEDED IN THIS SPACE

Figs. 1 and 2. Samples of the Boiler Room and Engine Room Log Sheets

WEEK END BOILER ROOM JOBS — DATE:

JOB	TO BE DONE BY	COMPLETED BY
CLEAN FRONT OF STOKER	6-2 SHIFT	
CLEAN BLADES OF BOTH FANS	6-2 "	
BLOW OUT COMBUSTION CONTROL LINES	6-2 "	
TEST BOILER CIRCULATING TUBE BLOWOUTS	6-2 "	
BLOW OUT FAN MOTORS	6-2 " (SUN.)	
BLOW OUT FAN PIVOT BEARINGS	6-2 "	
CLEAN SLAG OFF BOILER TUBES	6-2 "	
CLEAN FIRE AND REMOVE ALL CLINKERS	2-10 " (SUN.)	
LUBRICATE STOKER CRANK SHAFT	2-10 "	
LUBRICATE STOKER RAMS	2-10 "	
LUBRICATE STOKER AGITATOR	2-10 "	
LUBRICATE ASH PIT DOORS	2-10 "	
LUBRICATE COAL LADDY	2-10 "	
CHECK OIL IN FORCED DRAFT FAN MOTOR	2-10 "	
CHANGE OIL IN FORCED DRAFT FAN	2-10 "	
CHECK OIL IN INDUCED DRAFT FAN MOTOR	2-10 "	
CHANGE OIL IN INDUCED DRAFT FAN	2-10 "	
WASH BOILER ROOM FLOOR	2-10 " (SUN.)	
INSPECT STOKER GEAR TUBE	2-10 "	
CLEAN UPSTAIRS FAN ROOM, BLOW DUST OFF BEAMS AND SKYLIGHTS AND CLEAN DOWN STAYS	10-6 " (SAT.)	

NO JOB IS TO BE CONSIDERED COMPLETED UNTIL BACKING IS CLEANED UP, GUARDS REPLACED AND TOOLS AND SUPPLIES PUT AWAY.

WEEKLY WORK SHEET FOR POWER HOUSE — DATE:

JOB	TO BE DONE BY	COMPLETED BY	REMARKS
RENEW OIL IN BOOSTER OIL FILTER AND CHANGE BAGS	2-10 Thurs.		
BLOW JACKET DRAIN TO OUTSIDE	2-10 Thurs.		
SERVICE GENERATORS, EXCITERS AND MOTORS	6-2		
CLEAN VACUUM PUMP STRAINER	6-2		
INSPECT TURBINE VALVES	6-2		
CLEAN AIR JETS	6-2		
CLEAN AND OIL BOOSTER CHAIN ON RIVER PUMP. PUMP SHUT DOWN EACH MONTH.	6-2		
CLEAN SKIMMER OIL WATER SEPARATOR	2-10		
INSPECT BOILER SETTING	CHIEF		
CLEAN FILTER BOX AND RENEW THICK CLOTH FILTERS	6-2		

Figs. 3 and 4. Weekly and week-end work sheets

With this system and with this record system every engineer has a good opportunity to study engineering among excellent surroundings. We have about everything a modern power plant needs, including an engine room library. Most of the reading matter in this library consists of manufacturers' data and catalogs on the equipment installed. There are also hand books and a complete file of blue prints and instruction sheets covering the equipment installed in the plant.

It is quite surprising to see how quickly men begin to know the equipment and what they are doing in a plant when operated under these conditions.

Thermal Properties of Water

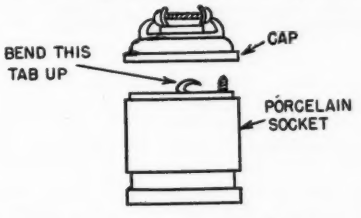
THERE IS nothing new about steam tables; mechanical engineers have used them in engine design and operation for nearly 100 yr, but the preparation of tables covering adequately the pressure and temperature ranges that are now common is a comparatively recent development. In 1923 the ASME sponsored researches on water and steam at several laboratories, and asked the Bureau of Standards to determine the specific heat of liquid water and its heat of vaporization. In his address as retiring president of the Philosophical Society of Washington on January 6, H. F. Stimson reviewed the Bureau's part in this project. He pointed out that the late N. S. Osborne, in taking up the Bureau's assignment, first studied the theory of "calorimetry of saturated fluids" and then proceeded to use this theory for the measurement of the enthalpy (formerly called total heat or heat content) of saturated liquid water and water vapor from 0 C to the critical temperature at 374.15 C. The precision of his results was such that it is hoped they will meet every requirement of engineering practice for years to come. The vapor pressure of water was determined from 100 to 374 C.

The vapor pressure of water between 0 and 100 has not been carefully determined since 1909, but a precision manometer has been developed with which Dr. Stimson plans to make measurements at pressure below 2 atmospheres. The vapor pressure of water can be measured with this manometer, to a higher relative precision than the precision to which the corresponding temperature can be measured with platinum resistance thermometers calibrated at the steam and ice points by routine methods. The calibration of thermometers at 100 C can be done with this precision manometer to an accuracy of 0.0001. In order to obtain this same accuracy for calibrations near the ice point, the triple point of pure water was used. Special triple-point cells have been made. The temperature of the triple point was 0.0100 C.

PRACTICAL HINTS AND KINKS

Porcelain Sockets

WHEN installing or assembling porcelain electric light sockets, bend the metal contact tab, as shown in the accompanying figure, to insure its making good electrical contact



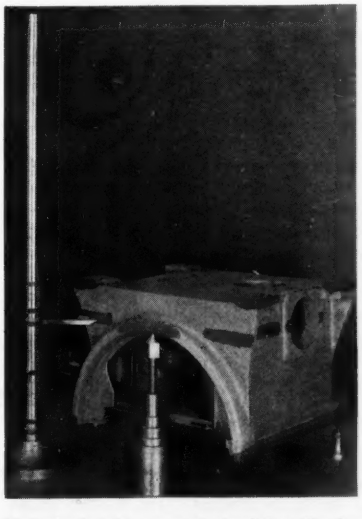
against the contact on the top part of the socket. If this is not done the socket may not light a lamp placed in it. The writer has seen this happen.

Multiple Height Gage

A MULTIPLE height gage designed by Charles Rohlfs of General Electric's Pittsfield Works inspection department has simplified scribing of gear housings and their inspection after machining, and considerably reduced layout time. Dial indicators can be clamped to the multiple scribers and set to required dimensions to inspect quantities of identical parts.

Relatively simple to make, the gage consists of a center column-rod threaded into the base and secured by a lock nut. The spacers and scribers, hardened and ground, are drilled to slide-fit the column rod. The spacers are ground to dimensions that will place the scribers correctly for the layout of the required lines for machining. After these are placed on the rod and correctly spaced, the assembly is secured by a cap nut. To compensate for the variations in unmachined castings, the complete assembly of spacers and scribers can be adjusted higher or lower, without disturbing any of the dimensions between the scribers, by loosening the lock nut and screwing the center column rod in or out of the base, as the case may be.

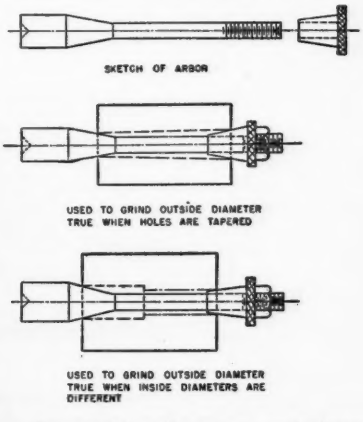
By using a set of spacers for each drawing, the scribers are easily spaced and secured, and any quantity of identical parts can be rapidly laid out. This new gage eliminates the use of the conventional gage, which had to be set for each line and the reading checked before scribing.



Multiple height gage devised by Charles Rohlfs

Special Arbor for Accurate Grinding

SPECIAL ARBORS for grinding, where a high degree of accuracy is required with respect to runout on the ground surface, have been designed and developed at General Electric's Pittsfield Works. They eliminate the necessity of having different arbors made to fit varied conditions, since they may be used on parts with tapered holes or those having holes with two different diameters. A greatly improved product is the result of using an arbor of this kind.


SKETCH OF ARBOR
USED TO GRIND OUTSIDE DIAMETER TRUE WHEN HOLES ARE TAPERED
USED TO GRIND OUTSIDE DIAMETER TRUE WHEN INSIDE DIAMETERS ARE DIFFERENT

The special arbors are made from hardened, ground steel with centers in both ends. The part of the arbor which turns the work is tapered 1⅛ in. to the foot, which is just enough to turn the work but not to bind in the hole. The removable tapered sleeve has the same taper on the spindle, and is a good fit on the straight shank of the arbor.

The Boiler Fireman's Handbook

By J. R. DARNELL

Firing with natural draft . . . Furnace design, a factor in operation . . . Ignition—how it is effected . . . Measuring fuel consumption on chain grates . . . Measurement of grate speeds . . . Banking the fire . . . Disposal of ash and siftings . . . Regular cleaning

XIII—Stoker Firing Methods—(Continued)

IN NATURAL draft chain grate stoker operation, like all natural draft operation (see Chapter IX)[1] the chimney must handle all of the draft work, i.e., it must not only cause the air for combustion to flow through the fuel bed but must carry off the products of combustion. It is highly important that the fireman take all precautions to see that there are no obstructions in the path of the air through the grate, that there is the least amount of resistance through the fuel bed and that the full effect of the chimney draft is exerted on the fuel bed and not dissipated through leaks along the ledge plates and around the end of the stoker.

In a large industrial plant the author once found a battery of natural draft chain grate stokers operated by firemen who used a high pressure water hose at the end of each shift to wash down ash and coal siftings from the upper to the lower pit. This meant that there was an unobstructed flow of air around the end of the stoker which diluted the CO_2 and thus caused a false flue gas analysis besides reducing the combustion rate of the stoker.

As shown by Fig. 1, to remedy the trouble, a wall was built at the rear end of the upper pit, extending upward to within about 2 in. of the grate surface. About 2 ft in front of this wall a similar wall of the same height was built and the space between the two walls filled with ashes. Siftings falling on top of these ashes effected a reasonably tight air seal as the grate surface dragged through this accumulation of ashes and cinders and thus prevented air from passing under the stoker and into the furnace without entering into combustion with the coal.

In plants where firemen are allowed to think for themselves and are given an opportunity to offer suggestions for the improvement of combustion conditions, the job of fireman should be something more than keeping the steam pressure at the required point on the gauge. If he is convinced that certain changes in the furnace design will effect better combustion and permit greater boiler output he should try to convince the management of the merits of his ideas.

Furnace Design Is a Factor in Operation

One of the most important factors in the successful operation of both natural and forced draft traveling grate stokers is the furnace design.

In some of the older installations water-backs are still in use. The two types of water-backs are commonly designated as low and high pressure. With the first, water is often supplied by the city water system or some other similar source. With the high-pressure system, the water-back pipes are connected to the boiler tubes and require no special attention except blowing out scale once in a while. With the low-pressure system it is important that circulation be assured before firing.

High percentages of overload and resulting high furnace temperatures have made some sort of side wall cooling necessary. Where pipes are provided for water cooling, similar methods of water supply are employed as with water-backs and the same points must be observed. Another method of side wall cooling is by the use of air-cooled refractories which will be discussed in more detail in another place.

Even where water-backs are connected to the boiler tubes and there is no trouble with the burning of these pipes, satisfactory results from a combustion viewpoint are not obtained and modern installations of traveling grate stokers are being provided with rear arches. A typical example of rear arch construction is shown in Fig. 2. Figure 1 also shows a typical chain grate stoker installation with a water-back at the rear. The original purpose of this water-back was to scrape any unburned fuel off the top of the ash going over the rear and also to provide a seal against the infiltration of air into the combustion chamber. The effect and distribution of this excess air is also shown in Fig. 2. But a seal was seldom, if ever, provided and, if the ash were allowed to pile up on the water-back, clinker formed on the tile above the water-back to such extent that it often stopped the stoker.

Another serious defect of water-back installations was the inadequate protection of the ends of the links or clips from the radiant heat of the furnace. Reflection of this heat onto these links, just at the point where the flat surface was broken when it

[1]April issue, p. 98.

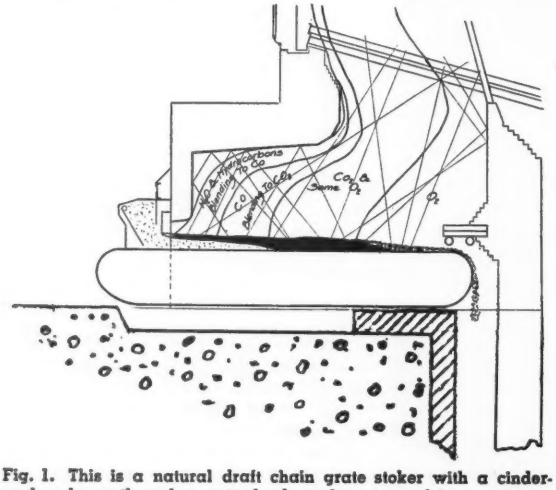


Fig. 1. This is a natural draft chain grate stoker with a cinder-seal underneath and a water-back at the rear end in an attempt to deflect the air and prevent infiltration along the bridge wall. The cinder seal should be used with either natural or forced draft

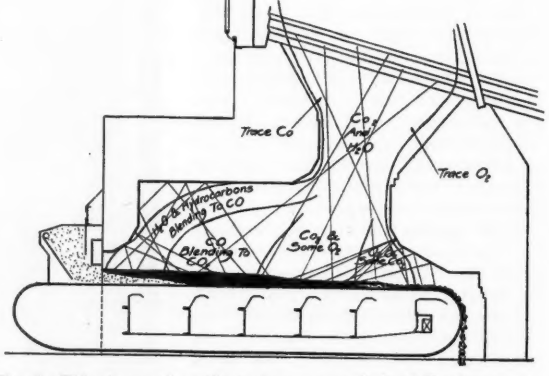


Fig. 2. This shows the effect of a rear arch in deflecting excess air into the zone of combustion. Such furnace design may be used with either natural or forced draft

passed around the rear end of the stoker, burned the ends severely on the upper corners.

With these defects and no appreciable commendable points, waterback installations have gone into the discard and the modern traveling grate stoker installations are being provided with rear arches not only to prevent burning of the links but to crowd the excess air from the rear forward into the path of the combustible gases. This is shown graphically in Fig. 2.

Ignition Is Effected by Arches

One of the difficult problems met in the use of traveling grate stokers is to secure ignition. This is particularly difficult for fuels low in volatile matter and relatively high in ash, such as coke breeze and small sizes of anthracite. In contrast to the agitation occurring in the fuel-beds of underfeed or overhead stokers, the fuel bed of a traveling grate stoker lies perfectly quiescent and the film of carbon dioxide around each of the upper fuel particles tends to prevent further ignition. Consequently, a refractory surface above the fuel-bed must be provided to reflect heat back to the fuel bed, with sufficient force to penetrate the carbon dioxide and ash films which envelop the fuel particles. This refractory surface is known as the ignition arch. Space does not permit much discussion of arches, but the more important points are length, height above the grate, location with reference to the tube bank so as to permit maximum radiation from fuel-bed to tubes, and width of throat between front and rear arch.

Measuring Fuel Consumption on Chain Grates

As mentioned in Chapter XII, determination of the grate speed provides a basis for a method of measuring fuel consumption, if scales or coal meters are not available.

Every make of chain or traveling grate stoker has a feed gate that can be raised or lowered to regulate the thickness of the fuel bed. If this height and the width of the stoker are accurately measured it is a simple matter to calculate the volume of fuel used per hour.

The density of different kinds of coals and also that of other fuels such as coke will vary with different shipments and for different localities but a cubic foot of bituminous coal averages about 50 lb per cu ft while the average of anthracite varies between 54 and 60 lb. Dry coke breeze weighs about 35 lb per cu ft but when wet it will hold from 10 to 15 per cent moisture and the weight will increase to an average of 40 to 45 lb per cu ft.

Measuring Grate Speed

Some sort of revolution counter is the best means of measuring grate speed but if such is not available, a simple method is by making a mark on one of the links or clips near the side frame and then by means of a rule and a stop watch, catch the speed between two points. The second hand on an ordinary watch may be used with a fair degree of accuracy if two persons are present.

Another method which also may be used is counting the revolutions of the main worm per minute if the ratio of gear reduction is known.

Ordinarily, in attempting to measure the grate travel with a rule, difficulty is encountered because the flat or horizontal surface of the grate is inaccessible behind the coal hopper. The detachable apron forming the front of the coal hopper extends so far forward that the links do not lie flat until they get under the apron. For this reason counting the revolutions of the main worm is much easier. If you do not know the relation between the revolutions of the main worm and the grate travel, it is a simple matter to get this figure some time when there is no fire on the grate. Remove the front apron and make a chalk mark on one of the links near the side just as it is about to move into a horizontal position. Then with a watch in one hand and a piece of chalk in the other, make a mark on the side frame just even with the mark on the link just as you catch the time with the second hand of your watch. At the end of one minute again make a mark on the side frame even with the mark on the link. The number of inches between the marks on the side frame will be the amount of grate travel per minute. Next, with the stoker running at the same speed, check the number of revolutions per minute of the main wormshaft. The number of inches of grate travel per minute divided by the number of revolutions of the main worm will then give the factor that may always be used for that size and type of stoker for determining grate speed.

The accompanying table was computed for coal consumption in pounds per hour with coal of 50 lb per cu ft and a grate speed of one inch per minute. For any other speed multiply the figures in the table by the indicated speed per minute. For example, if the stoker is 10 ft wide, the feed-gate height 6 inches and the grate speed 5 inches per minute, the table shows 1254 lb per hour for a speed of 1 in. per minute. Multiply by 5 gives 6270 lb per hour.

If, instead of bituminous coal, anthracite of 60 lb per cu ft is being fired, the figures in the table should be multiplied by a factor of 1.2, or if coke breeze of 40 lb per cu ft is used, the factor will be 0.8.

Table showing coal consumption in pounds per hour on chain grate stickers with a grate speed of one inch per minute and coal density of 50 lb per cu ft

Gate Height In Inches	Pounds Coal Consumption Per Hour With Grate Speeds of 1 in. per min. 50 lb per cu ft Stoker Widths in Feet															
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	125	146	167	188	209	230	250	271	292	313	334	355	376	397	418	439	460
2	250	292	334	375	418	460	500	542	584	626	668	710	752	794	836	878	920
3	375	438	501	564	627	690	750	813	876	939	1002	1065	1128	1191	1254	1317	1380
4	500	584	668	752	836	920	1000	1084	1168	1252	1336	1420	1504	1588	1672	1756	1840
5	625	730	835	940	1045	1150	1250	1355	1460	1565	1670	1775	1880	1985	2090	2195	2300
6	750	876	1002	1128	1254	1380	1500	1626	1752	1878	2004	2130	2256	2382	2508	2634	2760
7	875	1002	1169	1316	1463	1610	1750	1897	2044	2191	2338	2485	2632	2779	2926	3073	3220
8	1000	1168	1336	1504	1672	1840	2000	2168	2336	2504	2672	2840	3008	3176	3344	3512	3680
9	1125	1314	1515	1692	1881	2070	2250	2439	2628	2817	3006	3195	3384	3573	3762	3951	4140
10	1250	1460	1670	1880	2090	2300	2500	2710	2920	3130	3340	3550	3760	3970	4180	4390	4600
11	1375	1606	1837	2068	2299	2530	2750	2981	3212	3443	3674	3905	4136	4367	4598	4829	5060
12	1500	1752	2004	2256	2508	2760	3000	3252	3504	3756	4008	4260	4512	4764	5016	5268	5520

Banking the Fire

The procedure in banking the fire on either a natural or forced draft type of chain grate stoker is generally similar except that there are more steps involved with forced draft.

When taking a stoker off the line for banking, especially when the stoker has been operated at high rating, gradually decrease the air supply to the stoker by closing the air valves a little at a time. This will prevent damage to the stoker due to the large amount of heat absorbed by the arches and brickwork.

Fill the stoker hopper and shut off the fuel supply. Shut off the supply of forced draft air to the stoker, then close the air valves and the stack damper but do this only after the furnace is relatively cool, as the stoker will be damaged, if a large amount of heat is bottled up in the furnace. Raise the gate to a height of 12 in. and run the stoker at the highest speed until the hopper is empty. Leave no fuel in contact with the gate or the gate will burn out. Next slightly open the air valves to the compartment which is under the end of the green coal just run in and open the stack damper slightly. The fire will then burn slowly toward the front of the stoker. As the end of the fire comes over each zone, the air valves to that zone must be slightly opened and all other valves kept

closed. When the fire reaches the front compartment, another hopper full of fuel must be run in exactly as described above.

After a banked period do not start the stoker until air has been blown through the grate for 4 or 5 min, or serious damage may result. The stoker grate surface during the banking period has become much hotter than when in normal operation, various parts have expanded and it must be cooled before starting.

Disposal of Ash and Siftings

Natural draft stokers have a greater percentage of air opening than forced draft and, as a result, a greater amount of unburned fuel will be in the upper pit. These siftings should be raked out on the floor and returned to the stoker hopper. With forced draft stokers, the siftings fall into the air compartments. If the grate surface is in good condition, the amount of siftings per day will be quite small but, if allowed to accumulate, this material will, in time, interfere with the air supply. Siftings should be removed at least once a month and inspection made at least once a week.

With either natural or forced draft, accumulation of ash in the lower pit may result in serious damage to the stoker. Cleaning should be at regular periods, the interval governed by the amount of fuel burned.

The Fundamentals of Electron Tubes

Part I. Introduction. Definition of Electronics . . . The Electron theory . . . Structure of the Atom . . . Composition of the atomic nucleus . . . Protons, Neutrons and Electrons . . . The concept of free electrons . . . Theory of electric conduction . . . Ionization . . . Types of electronic emission . . . Electrons always identical

By Ralph B. Immel

Control Engineer, Westinghouse Electric Corporation
East Pittsburgh, Pa.

THE COMPLEXITY of electronic apparatus is more imaginary than real. While the science of electronics deals with the generation and flow of electrons as the name implies, it is no more mysterious than any other electrical or magnetic phenomena. To many persons the word electronics immediately suggests radio apparatus, light beam controlled door opening mechanisms, electronic timers, spot and seam welding controllers. These devices appear to be very complicated to many persons as the fundamental principles of operation are not thoroughly understood. The electronic tube is not a novelty, but is a very useful tool which alone possesses characteristics to perform a particular operation much better than any other device. Tubes are often used to function the same as a single pole manually operated knife switch or as a single pole magnet operated contractor. However, in certain characteristics the tube surpasses the knife switch or contactor as its speed of operation is infinitely faster and very little energy is required to initiate or stop current flow. Tubes, furthermore, can not only start and stop the flow of electricity but they can permit any portion of the total current to pass, always under perfect control. Tubes respond to variation in potential of millions of cycles per second, they are able to detect minute electrical charges and variations in current, they can rectify alternating currents or convert direct current into alternating current of any frequency, they can produce light or X-rays, they can generate alternating current of any frequency. In the control of industrial processes, tubes have endless applications. Recent developments in induction heating and the curing of plastics show promise for a great future in the application of electronics to that industry. A thorough understanding of the generation of electrons and the characteristics of electronic tubes and circuits will provide solutions to the seemingly impossible problems.

In reality, the flow of current in a wire, the generation of electrical energy by rotating machinery, or the creation of energy by chemical means could also be included in the realm of electronics as there is a movement or flow of electrons in the external circuits. The arc lamp which produces a dazzling light from the current flow between two carbon rods or the arc drawn from an electric welding rod and the work are very good examples of electron flow. However, the arc lamp and welding apparatus are not usually considered electronic devices. In general, to limit the scope of this scence, the word *electronics* is usually associated only with apparatus in which the conduction current flow through a vacuum or gaseous space. The vacuum tube detectors, rectifiers, amplifiers, or oscillators of a radio receiver, photoelectric tubes, neon signs, fluorescent lamps, X-ray apparatus, ignitrons, and thyratrons are all good and typical examples of electronic apparatus.

According to the Electron theory, an electric current consists of a large number of minute and electrically charged particles of matter which are called *electrons* and which flow as a stream in a conduction medium. The electron has a mass of 9×10^{-28} gram and a charge of 1.5910^{-19} coulomb. A flow of one ampere of electricity requires 63,000 million, million electrons to move past any point in a conductor every second. The electrical impulse or energy is transmitted through the conductor at the velocity of light or 186,000 miles per second.

The electron theory assumes that all matter is made up of very small groups of particles, known as *atoms*. As shown by Fig. 1, the atom consists of a positively charged center or nucleus, surrounded by one or more negatively charged *electrons*. These electrons revolve about the positive nucleus in a very definite path and are generally held to this fixed orbit. The nucleus is usually a complex structure composed of positively charged particles called *protons*. The number of protons determines the total positive charge on the nucleus and also the number of electrons in the outer orbits. In addition to the protons, many atoms also have other particles in the nucleus which carry no electric charge and are therefore called neutrons. The neutrons play no part in the electrical characteristics of the atom but they do contribute to the total mass of the atom. A neutral atom has just enough negatively charged electrons in the outer orbits to neutralize the total positive charge on the nucleus. Electrons can be removed from the outer orbits of the atoms but if they are so removed, the atom is left with an overall positive charge and it then is no longer neutral; it will tend to recapture the lost electrons so as to re-establish its normal neutral condition.

As already indicated, an electric current is nothing more than a progressive moment of electrons along the length of a conductor. It so happens that all electrons are not held to the atoms with the same degree of attraction. In the atoms of some

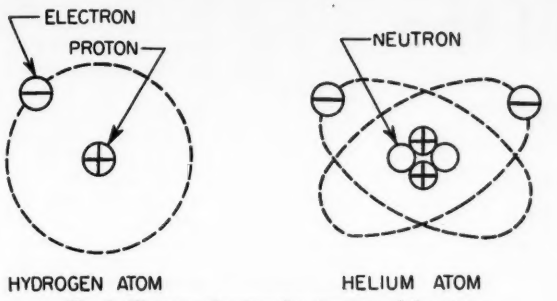


Fig. 1. Diagram showing the structure of the atom

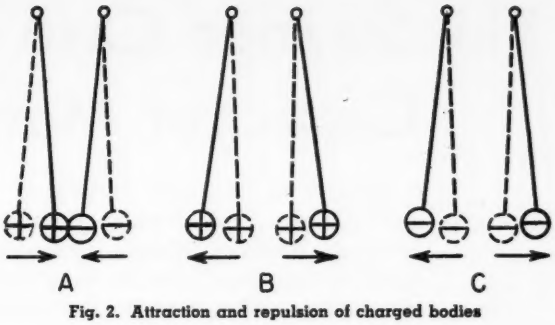


Fig. 2. Attraction and repulsion of charged bodies

substances the electrons in the outer orbits are held relatively loosely; in other substances they are held very firmly. Whether a current will flow in a material when an electromotive force is applied between two points is determined mainly by the number of relatively free electrons in the terial. In materials where the outer electrons are held loosely, such an electromotive force will tear the electrons away from the atoms and they will travel along the conductor. In their course of travel, these electrons may at times attach themselves to other atoms but in general there will be a steady migration of free electrons towards the positive terminal. This movement of electrons is more in the nature of a drift than a free flow.

If a current flows in a material when an emf is applied, the material is said to be a *conductor* and its conductivity is directly proportional to the number of "free" electrons per unit volume of the material. Metals such as silver, copper, and aluminum contain a great number of relatively free electrons, consequently, these metals are considered very good conductors. Materials that have very few or no relatively free electrons such as glass, porcelain or Bakelite are called *isulators.*

When an atom or a *molecule* (which is a group of atoms) has lost one or more electrons, it is no longer neutral and is known as a positive *ion.* The ion retains the approximate weight of the neutral atom or molecule but has a positive electric charge proportional to that of the freed or lost electrons. There are a number of ways by which electrons may be separated or emitted from the atom or molecule.

When a swiftly moving electron in a gas collides with a molecule, the impact force may be sufficient to free or knock out one or more electrons. Production of electons and subsequent positive ions by this method is known as ionization by *collision.*

Electrons are omitted from certain materials when they are exposed to ultra-violet light, or visible light. This method of electron emission is known as the *photo-electric effect.*

When a stream of rapidly moving electrons strike a solid body, such as the anode in an X-ray tube, electrons are knocked out of the solid material. Production of electrons in this manner is known as *secondary electron emission.*

It is also possible to pull electrons directly out of a solid material by subjecting the surface of the material to a very intense electrostatic field. The freeing of electrons by this manner is known as *field emission.*

When the temperature of a solid body is raised above a critical value, electrons will escape from its surface and into the surrounding space. This method of freeing electron is one of the most common, important, and effective means of electron liberation. It is known as *thermionic emission.*

Electrons are always identical regardless of the manner in which they are freed. As an electron has a definite charge of electricity, its motion can be effected and changed by either an electrostatic or electromagnetic field. Figure 2. shows the electrostatic attraction of positively and negatively charged particles for each other and the repulsion of like charged particles. This phenomenon can be demonstrated with small pith balls suspended from a thread and charged by any of the common means of generating a static electric charge. An electron or ion in a vacuum or gaseous tube is either attracted or repelled in the same manner by the electro-static field emanating from the anode or grid element.

To understand and fully utilize electronic tubes and apparatus, it is essential to understand the basic principles of the electron theory. However, the lack of a complete understanding of this theory should not deter a person from taking advantage of the mort common functions and applications of electronic tubes. In this case, *it is necessary only to assume that electrons do exist and that they are negatively charged particles of matter.*

As many regular readers may recall, we covered the subject of electron tubes rather thoroughly in a series of articles which ran from 1936 to 1939. At that time electronics had not achieved the glamour it has today and readers exhibited less interest in the articles at the time they appeared than they did a few years later when back numbers of the articles were no longer available. Because of the frequent requests for reprints of these articles that come in to us, from time to time, we have felt that another series of a somewhat similar nature would well be justified. Accordingly, we take pleasure in being able to present this new series by Ralph Immel of the Westinghouse Electric Corporation. In this series, the author describes the principles of operation and the uses for the most important industrial types of electron tubes. This first article is merely an introduction to the subject, acquainting the reader with the fundamental electron theory upon which the operation of all tubes is based. This will be followed by chapters describing the operation of specific tubes. Electron tube terms, definitions and ratings will be covered in other chapters so as to give the reader a background of the limitations and the knowledge for properly applying tubes. Later on, Mr. Immel will provide basic information on most of the auxiliary equipment which together with tubes make up the complete industrial electronic controller. Mr. Immel writes in a simple, straight forward style and his treatment of the subject is free from mathematics. These articles are written essentially for the practical engineer who wants to learn something about electron tubes and their applications in industry

---

The TINIEST ball bearing in the world is but 2.7 millimeters in diameter. Slightly larger than the head of a pin, it contains 3 of the smallest steel balls ever made, glass smooth and only 1/25 of an inch in diameter. It takes 111,111 of them to weigh a pound. These pivot bearings are used in Norden bombsights and many supersensitive flight instruments replacing jewels which might crack under vibration.

The Strange Case of the Capacitor Motor

A Report to Thomas A. Walsh, Manager, Light and Power Department, Town of Hudson, Mass., by Robert W. Bordewieck, Instructor in Electrical Engineering, Worcester Polytechnic Institute

AN INDUCTION MOTOR at an ice plant in Hudson, Mass., was subject to erratic current fluctuations which appeared to occur only when the load on the generating station of the Hudson Power and Light Co. was running light. The trouble was due to the large fifth harmonic current drawn by the capacitors of the motor. At low load the harmonic content of the voltage increased and caused the current to increase and trip the thermal overload relay. The effect was objectionable mainly when one generator, No. 2, was supplying part of the light load. This phenomenon is new and did not occur during over ten years of satisfactory service preceding 1944.

The motor in question was an Ideal Electric and Mfg. Co. Noel Polyphase Capacitor Motor, Class AA-H-N, No. 79455, 25-hp, 2300-v, 1170-rpm, 3-phase, 60-cycle, 5.3-amp., 444-frame, temperature rating 40 C continuous, and 100 per cent pf. This motor is connected to a Frick Ammonia Compressor through a V-belt drive and has a 15 kva, 660-v, 3-phase, 60-cycle, 13.1-ampere, 91.5-micro farads capacitor. The winding of the machine may be shown schematically as shown in Fig. 1.

It may be shown that the induction motor acts as a transformer and steps the 2300-v supply down to 660-v or less to apply it to the capacitor. The capacitance of the capacitor used was large and in present day practice would be considered excessive as it corrects the motor to unity pf at full load. However, with a harmonic voltage impressed at 300-cycles (fifth harmonic), the reactance was reduced to a small value (one-fifth of its value at 60-cycles). Thus even though the fifth harmonic voltage was low it sent a considerable current through the capacitor. The current waveform of the motor was shown on a cathode-ray oscilloscope, with and without the capacitors. The fifth harmonic content was tremendous; in fact it was so large that it appeared as if the line inductance in series with this capacitor formed a series resonant circuit. In this case only the resistance of the line limited the flow of fifth harmonic current. Substitute capacitors were not available so this theory could not be investigated at the time. When the capacitors were disconnected the waveform was a pure sine wave as near as could be determined.

If the circuit were resonant for the fifth harmonic the circuit could be drawn as shown in Fig. 2.

Considering only the 300-cycle component, the vector diagram of the circuit may be drawn as in Fig. 3, assuming series resonance. Note that the IX_c voltage is greater than the generated 300-cycle voltage.

A 4000-v line was installed about two years ago at the power station and the change of lines may have resulted in a change in inductance in the lines. If it was not series resonance, then the answer is that the harmonic content of the voltage of the station has increased. This is doubtful, since it is when old generators are on the line that trouble occurs, and, if harmonics were introduced because of age, they would be even and not odd multiples of the line frequency.

At the power station the waveforms of the generators were viewed and results noted at no load. Numbers 1 and 2 had no noticeable harmonic content. Number 3 had a dent in its wave which may have been due to improper operation of one of the Diesel engine's cylinders or to a faulty winding—probably the former. Number 4 had a small harmonic voltage as did No. 6. Number 5 was not running at the time. Current waveforms of the generators were not taken but might show something of interest.

In the November, 1944, issue[1] we presented an interesting electrical problem under the above title, which involved the peculiar behavior of a 25 hp, 2300-v capacitor motor driving a refrigerating compressor in an ice plant. This motor was installed in the Lampson Ice House at Hudson, Mass., and it was served from the lines of the Hudson Power and Light system. As fully explained in the November, 1944, issue, this motor ran satisfactorily except when the load on the Hudson Municipal Lighting plant dropped to below around 1000 kw; then the motor at the ice plant would suddenly start to draw more current and the overload relay would trip the motor from the line. Because of this, the motor usually would trip out on Sundays, since that was normally the only day when the load on the station would drop as low as 1000 kw. On one occasion—Labor Day, 1944—the motor could not be kept on the line until the station load reached 1200 kw.

The line voltage remained fairly constant at all times so it was fairly certain that the trouble was not caused by voltage conditions. The suction head and the pressures on the compressor seemed to have no bearing on the behavior of the motor nor did the combination of generators at the station affect the action. The generators were driven by Diesel engines.[2]

Naturally, this problem created a great amount of interest and a large number of possible solutions were received. These were published in the January, 1945, issue. The majority of the solutions pointed to the trouble as being the result of resonance caused by a harmonic of the 60 cycle current, in fact, this seemed the only logical explanation but in the absence of oscillographic studies, it could not be proved.

In the meantime, however, investigations were undertaken by Robert W. Bordeweick, Instructor in Electrical Engineering at Worcester Polytechnic Institute at the request of Thomas A. Walsh, Manager of the Light and Power Department of the Town of Hudson. The result of Mr. Bordewieck's studies are presented here. As will be seen, they prove that the trouble was due to a harmonic, the fifth harmonic of the 60 cycle current. This 300 cycle current was resonant with the resonant circuit inherent in the motor circuit and this caused the motor to draw greatly increased current when this fifth harmonic was present. However, we are telling the story—read it yourself just as Mr. Bordewieck presents it in his report to Mr. Walsh. It is a most interesting study.

---

[1] Page 105.
[2] New Diesel Generating Unit for Hudson, Mass., p. 60, May, 1943.

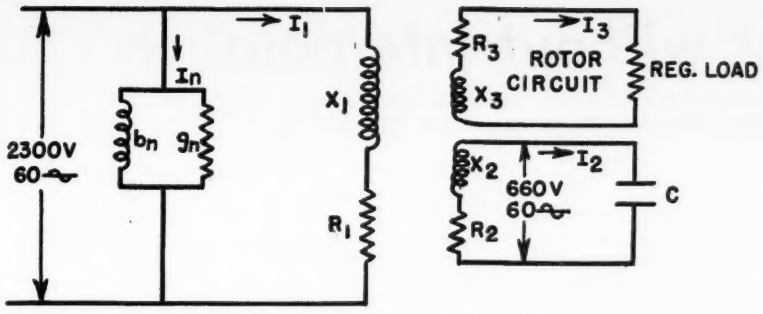


Fig. 1. Schematic diagram of the motor winding

When the generators were running with a load, the resultant voltage was sinusoidal. From these observations it does not appear as if the harmonic voltage could be high enough to cause a great deal of trouble. The noticeable harmonic was at most about 2 per cent. Regarding No. 2 generator which causes the trouble (at least the motor never seems to have quit when it wasn't on the line), it was noted that no noticeable harmonic was present even at no load. This means that if any harmonic voltage existed it was less than about 1 per cent.

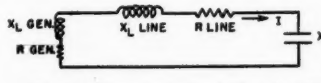


Fig. 2. Resonant circuit for the fifth harmonic

Since this resonance condition, if it is one, is affected by all the other loads on the line to some degree it could easily have been caused by recent installations. The only way to be sure is to measure the voltage harmonic content at the motor and at the plant. It should be less at the motor unless the circuit is close to resonance. A harmonic analyzer type of voltmeter should be used.

The probability is that No. 2 is not wound to eliminate the fifth harmonic as is done in some machines, and even though the fifth harmonic is low it causes some trouble. A check may reveal that the winding is such as to attempt to reduce both the fifth and seventh harmonic (accounting for good waveform) but to eliminate neither.

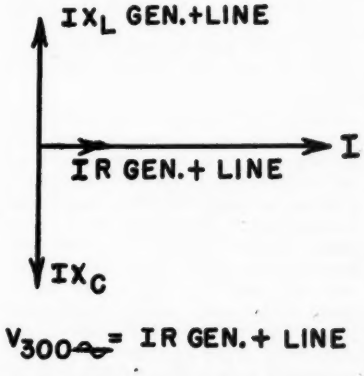


Fig. 3. Vector diagram showing resistance and impedance relations

Recommendations

Since the trouble occurs only with No. 2 on the line and the troublesome effect (i.e., the stopping of the motor) is caused by the fifth harmonic component of the current going through the capacitors, and then only with a certain light load on the power house, the following courses may be taken.

1. Reduce the size of the capacitors so that the fifth harmonic current will be reduced and not add to the motor current, causing the overload to trip. Reducing the capacitance by one-half should cut the fifth harmonic current in half and give the desired effect even if it is not in resonance.

2. Keep generator No. 2 off the line with light loads. Since the motor acts up seriously only with this generator on the line, this solution is self-evident.

3. Add inductance in series with the motor to decrease the fifth harmonic current. Since $X_L = 2\pi f$, the reactance of the inductor would be five times as great for 300-cycles. Thus, unless the added inductance resulted in series resonance this would greatly reduce the fifth harmonic current.

My recommendations are listed in the order of preference. Any one of the solutions should work perfectly, and as a matter of fact, the capacitors may be disconnected entirely and the current overload reset. In this case, however, it would be well to check with the manufacturer to determine whether or not this would result in overheating of the stator.

Fire Protection for Electrical Apparatus

ELECTRICITY, when properly used, is not a fire hazard; but, as mishandling and accidents are not always avoidable, electrical apparatus should be protected by suitable fire-extinguishing equipment.

For protecting small open and semi-enclosed rotating units, switches, appliances, and other commonly-used electrical devices, portable vaporizing liquid or carbon dioxide fire extinguishers may be employed. These extinguishers discharge non-conducting extinguishing agents that may be used on live equipment without danger of subjecting the operator to shock, causing short circuits, or damaging the equipment. In addition, they are effective on fires in the oil often used in transformers, circuit breakers, etc.

In installing these extinguishers, at least one large or two small units, bearing the approval of the Underwriters' or Factory Mutual Laboratories, should be placed near each piece of apparatus to be protected. More may be needed for such equipment as large motors, generators, and switchboards. They should be mounted where they are readily accessible, but not on the protected apparatus nor where they are likely to be cut off by fire.

Most small electrical fires may be quickly extinguished by applying vaporizing liquid or carbon dioxide and cutting off the apparatus involved. If deep-seated fires resist these extinguishants, water may be used, but not on live apparatus.

As the gases given off by burning insulation are poisonous, vaults and other enclosures containing electrical equipment on fire should not be entered without suitable gas masks. When such protection is lacking, it is desirable to stay outside the enclosure in the open air while fighting the fire. If this is not possible, leave as soon as the fire is out and do not return until all smoke and odors are gone.

All workers who may have occasion to control electrical fires should be taught how to use the extinguishers and what to do when the emergency arises. Prompt and effective action, ensured only by training, minimizes fire losses.

It's Dangerous to Wear Overalls

THE EXPERIENCE of W. E. Patten, with an empty tomato can, (May POWER PLANT ENGINEERING) recalls a similar one I had in railroading several years ago.

An engineer reported trouble with right hand injector "kicking" off. An examination of strainers, etc., showed everything clear. The "gun" worked perfectly until the engine was put in motion, then "kicked" off.

Running her back into the roundhouse, we emptied the tank and discovered an old overall jacket. This lay dormant in the bottom of tank when engine was still, but got in action on the road floating around, dodging baffles and coming to rest over injector outlet.

The usual blowing back would dislodge it, but when injector was put on, the suction and train motion would draw it back again.

Paraphrasing the maxim, trifles make perfection, they also make a lot of trouble.

Wilkes-Barre, Pa. THOMAS M. STREET

Logarithms without Interpolation

New Graphic Table combines Logarithms and Anti-logarithms so that either can be read in terms of the other without interpolation

No ENGINEER needs be sold on the value of logarithms. They can be used to simplify many engineering calculations and where long and tedious computations are involved they can save many hours of labor.

All who use logarithms know, of course, that in every computation involving their use, it is necessary to consult logarithmic tables, not only to find the logarithms of numbers but also to find the numbers corresponding to the logarithms of the results obtained in the computations. The tables which have been in general use are essentially "one way" tables. It is necessary, therefore, to have recourse to the process of interpolation which is always troublesome and entails a considerable source of error, besides taking up much time. True, the ordinary tables have annexed to them various forms of auxiliary tables of proportional parts to assist in the process of interpolation, but at best the process is quite involved.

Another disadvantage of the ordinary tables is the fact that they give the five-place logarithms of only those numbers which have four places, or a total of 9000 logarithmic values corresponding to the 9000 numbers from 1000 to 9999. Since, however, there are in all 100,000 five-place logarithms (.00000 to .99999), it is clear that the ordinary tables give only 9 per cent of all possible five-place logarithms. It follows also that of the 90,000 five-place numbers (10,000 to 99,999), the ordinary tables cover only 10 per cent, namely, the four-place numbers given in the table, to which a zero should be annexed to bring it to five places. The remaining values must be determined by the process of interpolation.

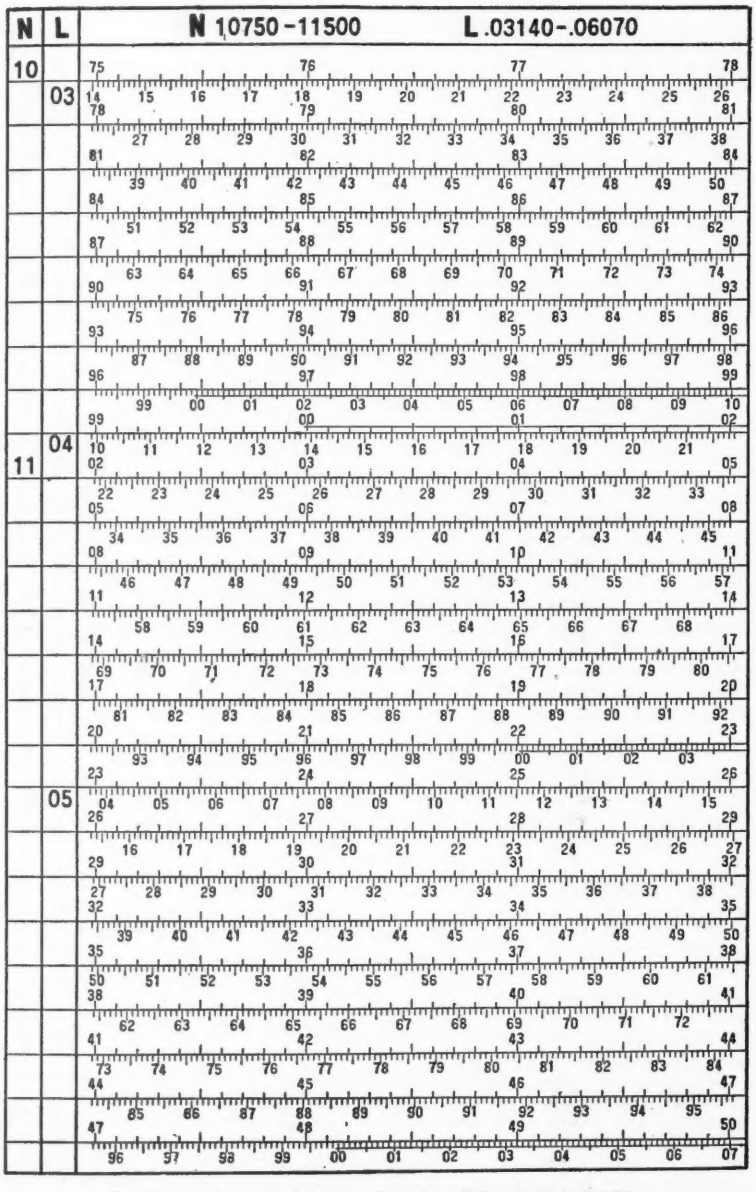


Fig. 1. Sample page of the new Lacroix and Ragot graphic table

These disadvantages of the ordinary logarithmic tables are eliminated in a new kind of table devised by Adrien Lacroix and Charles L. Ragot, and published recently by The Macmillan Company of New York. This table is in the form of a graphic scale which combines all the five-place numbers and all five-place logarithms so that either one of them can be read directly in terms of the other, without interpolation. The simplicity with which this graphic scale is read, the elimination of the auxiliary tables of proportional parts, and above all, the accuracy of the results obtained, make it more rapid, more convenient and reliable than all other forms of logarithmic tables.

This new graphic table is extremely compact. It embodies in 40 pages, without the need for interpolation, all that is contained in an ordinary table of some 380 pages.

A sample page of the graphic table is shown in Fig. 1. As will be noted it is somewhat like the scale of a long slide rule, cut up into short lengths and assembled on the pages of a book. It consists of a numerical scale and a logarithmic scale, both having a line as a common base, and the values of each scale are represented by graduations placed so that a value on either scale can be read directly in terms of the other without interpolation.

The illustration in Fig. 2 explains how the table is actually used. Referring to Fig. 2, the numerical leading digits are located in the marginal column headed "N." The logarithmic leading digits are located in the marginal column headed "L." The numbered graduations along either scale bear the next two digits; that is, the third and fourth digits in the five-place table. The upper scale is the numerical scale and contains all the numerical values from 10,000 to 99,999 in the five-place table. In a similar four-place table, this upper scale con-

KEEP DOWN PRODUCTION COSTS

with... Tight Valves ON AIR, STEAM, AND WATER LINES

Efficient Lubrication OF BEARINGS

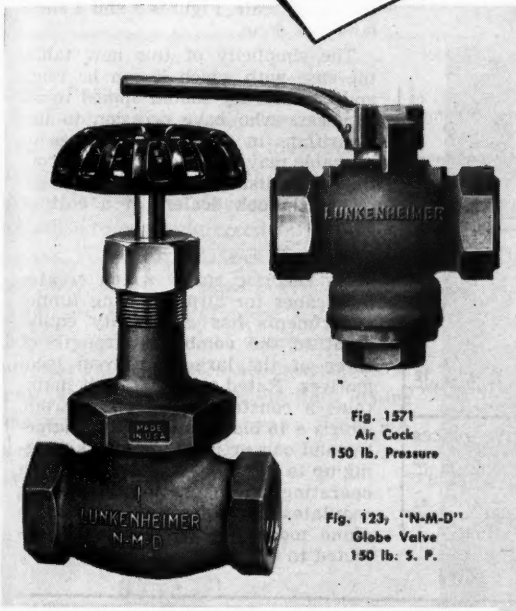


Fig. 1571
Air Cock
150 lb. Pressure

Fig. 123, "N-M-D"
Globe Valve
150 lb. S. P.

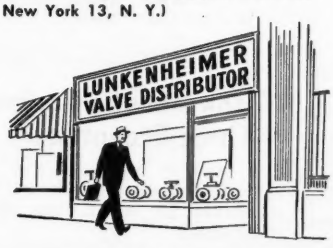
Leaky valves, permitting the escape of steam, air, or water, are wasteful in themselves—doubly wasteful in their effect on production costs and operating efficiency.

Inadequate, hand-method lubrication is another cost booster . . . increasing expense of machinery repair, of lubricant, of inspection time.

And—ultimately—*both* leaky valves and inefficient lubrication mean a *waste of fuel.*

Lunkenheimer Valves and Air Cocks have a rugged durability and simplicity of design that makes them *stay tight* with the very minimum of maintenance . . . Lunkenheimer Automatic Oilers feed the right amount of oil, in the right way, at the right time, to the right place . . . These and other Lunkenheimer products are famous for their outstanding performance record.

The Lunkenheimer Co., Cincinnati 14, Ohio, U.S.A. (Branch Offices: New York 13, Chicago 6, Boston 10, Philadelphia 7. Export Department: 318-322 Hudson St., New York 13, N. Y.)



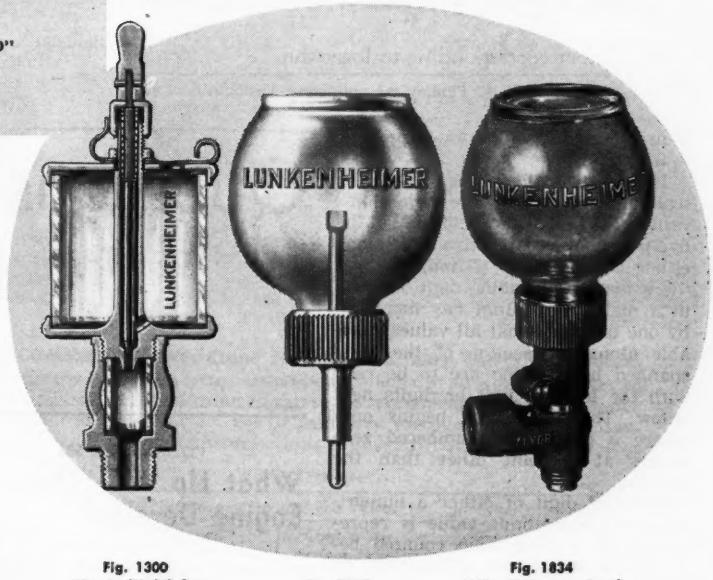


Fig. 1300
"Sentinel" Oil Cup
with Sight Feed

Fig. 1815
Bottle Oiler

Fig. 1834
"Alvor" Constant Level
Oil Control

A Lunkenheimer Distributor is located near you, fully equipped to assist with your maintenance and operation problems. Call on him.

LUNKENHEIMER VALVES & LUBRICATING DEVICES

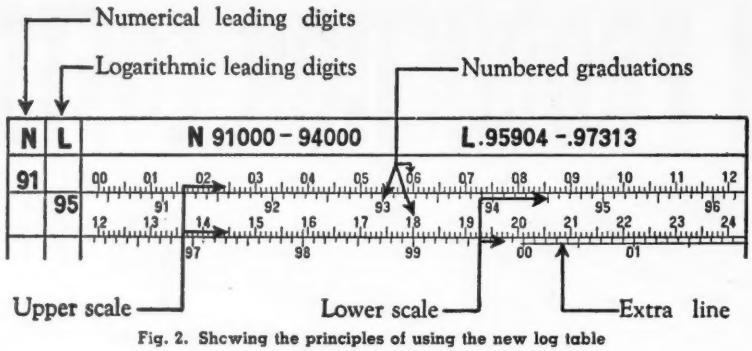


Fig. 2. Showing the principles of using the new log table

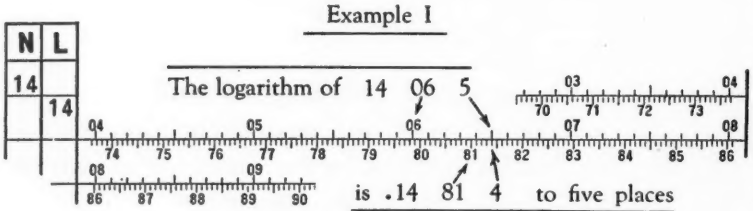


Fig. 3. Finding the logarithm of 14,065

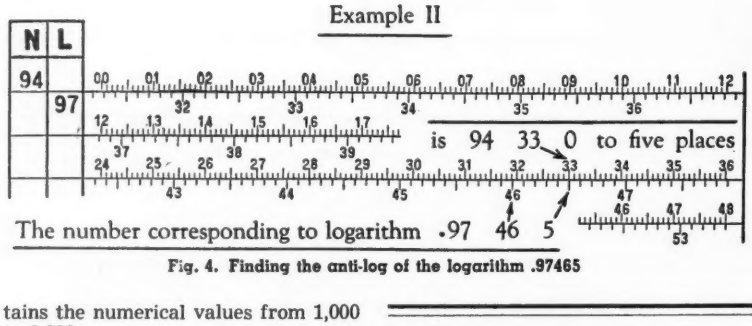


Fig. 4. Finding the anti-log of the logarithm .97465

tains the numerical values from 1,000 to 9,999.

The lower scale is the logarithmic scale and contains all the logarithmic values from .00000 to .99999 in the five-place table. An extra line along either scale is used to indicate that the value of the leading digit or digits in a marginal column has increased by one unit, and that all values readable along the section of the scale spanned by the line are to be read with the leading digit or digits next below. This extra line begins only where a graduation numbered zero occurs at a point other than the margin.

The last digit of either a numerical or a logarithmic value is represented by a graduation counted beyond the numbered graduation on which the two preceding digits have been found. The graduation which represents the last digit of the known value is the point of reading, opposite to which the last digit of the value to be found is read.

To find the logarithm of a number it is necessary first to turn to the page having the leading digits in the marginal column headed "N." Then, along the upper scale which is adjacent, find the next two digits on the numbered graduations. The point of reading will then be found by counting as many graduations beyond this numbered graduation as there are units in the last digit. The logarithm is then read directly on the lower scale, without interpolation, in the same manner as the number was located on the upper scale, using, of course, the leading digits in the "L" or logarithmic leading digit column, which precedes that section of the lower scale.

To find the number corresponding to a logarithm the process is merely reversed, that is the point of reading is located on the lower scale, and the corresponding number can be read directly, without interpolation, along the upper scale. Figures 3 and 4 show how it is done.

The simplicity of this new table, the ease with which it can be read, and its accuracy should appeal to all engineers who have occasion to use logarithms in their work. Copies of the table may be obtained direct from the Macmillan Company or through technical book dealers at a cost of $1.75.

AN ELECTRIC MOTOR which creates hurricanes for airplane wing tunnel experiments has a capacity equivalent to the combined strength of three of the largest railroad locomotives. Rated at 18,000 hp it maintains a constant speed of 514 rpm, whirls a 16 blade fan, 24 ft in diameter and can produce air blasts ranging up to 700 miles an hour. A clutch operating on magnetic principles regulates the fan speed so that the plane models or parts can be subjected to exact wind conditions.

Questions And Answers

Question No. 303

What Hp Will This Engine Develop?

1.—IF A 22-in. by 42-in. by 48-in. compound engine draws 14,000 lb of steam per hour, operating at 74 rpm, throttle steam pressure (saturated steam), 145-psi gage, receiver pressure 3-psi gage, vacuum 26-in., how much horsepower will it develop?

2.—With speed, throttle pressure and vacuum the same as in 1, but with 5-psi gage receiver pressure and steam consumption of 16,000 lb per hr, what will be the horsepower?

3.—With speed, throttle pressure and vacuum the same as in 1, but with 8 psi gage receiver pressure and steam consumption of 18,000 lb per hr, what will be the horsepower?

Willimansett, Mass. H. J. A.

Question No. 304

How About a Corliss with Three Eccentrics?

ONE OF MY MEN was asked the following question during his examination for a 2d class engineer's license:

"What can you tell me about a single Corliss engine with three eccentrics?"

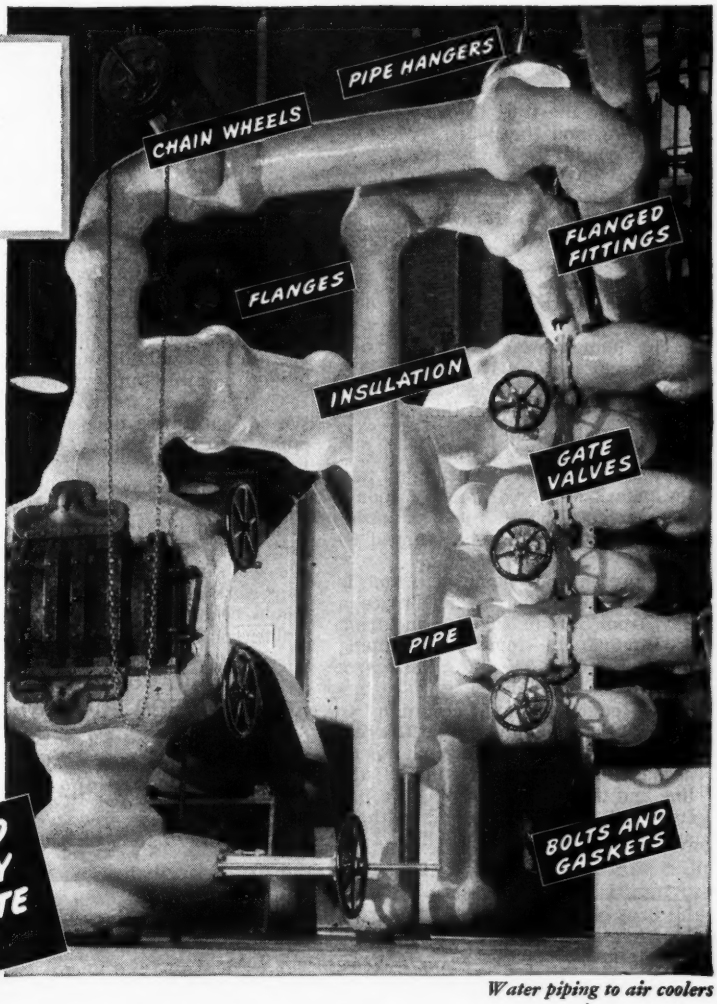
Comments from Q & A readers will be appreciated.

Pittsfield, Mass. E. C.

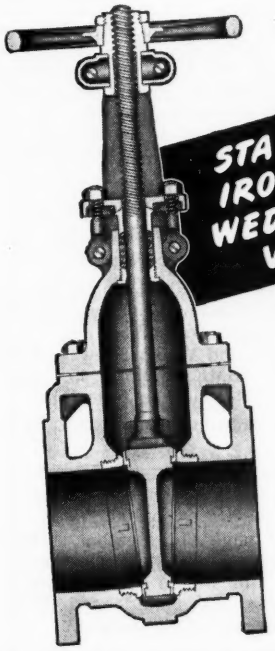
How the Complete CRANE Line Simplifies Piping Replacement Work

ONE SOURCE OF SUPPLY
ONE RESPONSIBILITY
ONE STANDARD OF QUALITY

The unusual completeness of the Crane line is of distinct advantage in "converting" piping systems. See the service recommendations below for Standard Iron Body Gate Valves. Here's a typical Crane solution to many deferred valve replacements. Your Crane Branch or Wholesaler supplies all your piping requirements from the world's greatest selection in brass, iron, and steel equipment. One standard of quality in all materials and one responsibility for them help insure the best installations. Crane Co.'s 90-year manufacturing experience insures long-lasting dependability.



Water piping to air coolers



SERVICE RECOMMENDATIONS: **Crane Standard Iron Body Wedge Gate Valves** are suited for many services in factories and power plants, at all working pressures up to 125 pounds steam. Brass trimmed valves are recommended for steam, water or oil lines; all-iron valves for oil, gas or fluids that corrode brass but not iron. Made in O.S.&Y. and Non-Rising Stem patterns. See page 101 of your Crane Catalog.

Working Pressures

Size of Valve	Screwed or Flanged End Valves		Hub End Valves
	Saturated Steam	Cold Water, Oil or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-in., Crane 150-Pound Cast Steel Gate Valves are recommended. (For sizes under 2-in., use Crane Clamp Gate Valves.)

CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. • *Branches and Wholesalers Serving All Industrial Areas*

CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

Question No. 305

How Control Village Water System from Pressure?

I AM A MEMBER of the village council. We have a water works system and I would like to see it placed on automatic control. The older members say it can't be done because one engineer told them so. Since I am not an electrician, I wonder if you would take the time to draw me off a drawing and the necessary equipment to hold the water level at a high and low range from the water pressure in the line and not by the float system. Also a drawing of float system in the wells to protect the pumps when the water is low in the wells. These are dug wells. I am sending a rough drawing of the outfit.

The pumps, which are of course centrifugal motor-driven pumps, are down in the wells. The No. 1 well is 69-ft deep; the pump in this well has about an 8-ft suction lift. The No. 2 well is 59-ft deep; the pump in this well is down in the water. I am told the pumps were guaranteed to pump 50 gpm each but on test when installed each pump alone pumped 60 gpm.

At present, one pump at a time is operated. Pumping is done twice a day, from 5:00 to 7:00 am and from 4:00 to 6:00 pm—four hours pumping in 24. We have 350 water customers plus the school building.

The engineer said, according to some of the councilmen, that the reason it can't be put on automatic is on account of the houses feeding off the line and that we should put in a line from the wells to the tank without any houses feeding off the line. I believe that a lot of people would have to open a lot of valves at the same time to affect the pressure on the line.

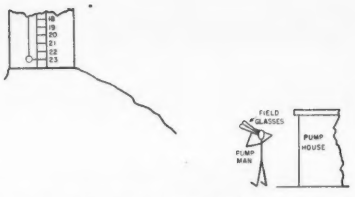


Fig. 2. No, he is not looking for Nazi planes. This is merely the way the pump man reads the tank indicator from the pump house with a pair of field glasses, says F. J. H.

Would it be O.K. for both pumps to be put on automatic at the same time or how could this be arranged so if one well is low and the tank is low, the second pump will start to operate? I would like to have this to lay on the table to prove my point.

The wells seem to fill up with sand. Would you advise the use of a sand pump and how should it be installed to get the best results?

We also have trouble with the concrete tank leaking. Could you recommend a paint for the inside of the tank walls after lowering the water? The walls would still be wet, so perhaps some kind of a sealing material would be best.

Ohio. F. J. H.

How Calculate Efficiency of This 2500-kw Turbine?

Errors in Answer to No. 266

Editor's Note: The following correspondence took place between George Neilson and Walter Heidecker, who presented the answer to Question No. 266 on page 112 of the October, 1944, issue. As will be seen, there were a number of errors in the published answer. Some of these errors were due to Mr. Heidecker and others were due to typographical errors here. It seems rather strange that so long a time has to elapse to have errors of this type pointed out to us. As Mr. Heidecker says in his letter to us, "sometimes one wonders if the readers understand half the stuff that is printed in the Questions and Answers Department. It took six months for them to get down to a little constructive criticism. There certainly should have been a whole sock full of letters, but they may be afraid of hurting the writer's feelings." The following is the letter received from Mr. George Neilson:

In the October, 1944, issue of POWER PLANT ENGINEERING the streamlined heat balance diagram to Answer No. 266 is not quite correct as printed, in my opinion. The balance checks but the feedwater return to the boiler arrow is in the wrong direction. As the balance is printed, there is heat being removed where it should be entering the system. Will you please check and let me know if the above is right or wrong?

Signed, GEORGE E. NEILSON.

A copy of this letter was forwarded to Mr. Heidecker and he wrote Mr. Neilson direct as follows:

A copy of your letter to POWER PLANT ENGINEERING of April 26 regarding Answer No. 266 in October, 1944, issue of POWER PLANT ENGINEERING. You are quite right about the arrow in the heat balance. It does point in the wrong direction. There are some other corrections also. In the tabulation of steam data, line 2, "Entropy of steam leaving No. 2 turbine" should read 2.004 (for 1.5 in. Hg) instead of 2.04. (For ¾ in. Hg, it would be 2,064. — Ed.) The formula for figuring turbine losses should read

$$1.00 - \frac{0.04}{\sqrt{\frac{\text{Kilowatt Rating}}{1000}}}$$

The original formula was taken from "Economy Characteristics of Stage Feedwater Heating," by E. H. Brown and W. K. Drewry, Transactions ASME, Volume 45, page 713, 1923. It reads as follows:

Loss in per cent at normal rating =

$$\frac{4}{\sqrt{\frac{\text{Kilowatt Rating}}{1000}}}$$

On page 116, October, 1944, issue of POWER PLANT ENGINEERING, the 14th line in the first column in the calculations should read "Btu converted in No. 2 turbine."

Some of the readers did not understand the meaning of the word efficiency which in this case is interpreted as the ratio of result to effort. Thermal efficiency should be the heat converted to mechanical energy at the turbine shaft, divided by the heat added to the water cycle. The

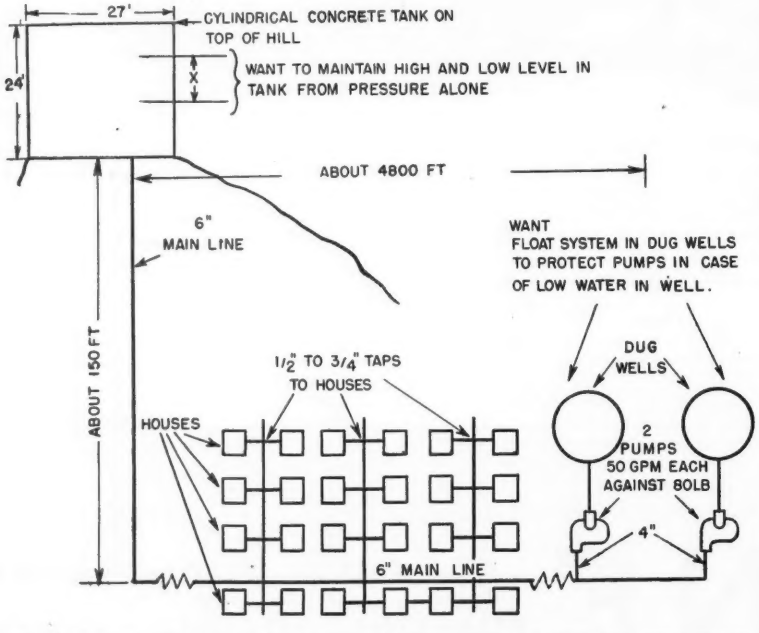
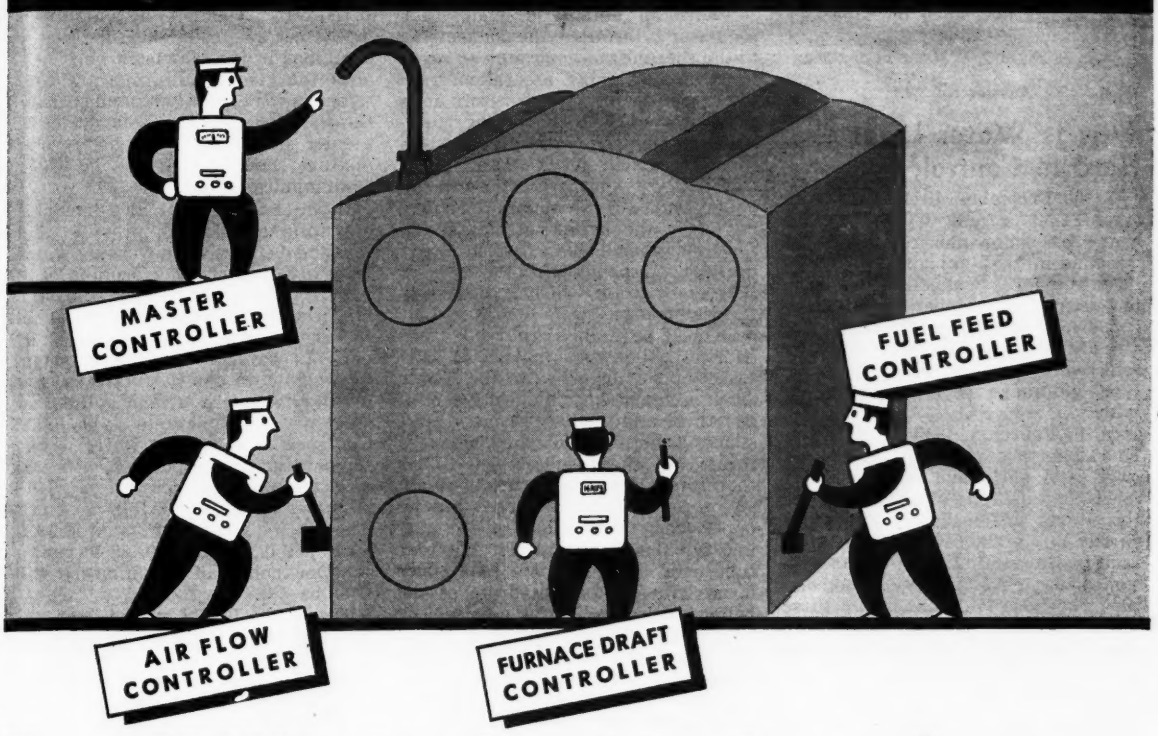

27'
CYLINDRICAL CONCRETE TANK ON TOP OF HILL
24'
X
WANT TO MAINTAIN HIGH AND LOW LEVEL IN TANK FROM PRESSURE ALONE
ABOUT 4800 FT
6" MAIN LINE
WANT FLOAT SYSTEM IN DUG WELLS TO PROTECT PUMPS IN CASE OF LOW WATER IN WELL.
DUG WELLS
1½" TO 3/4" TAPS TO HOUSES
HOUSES
ABOUT 150 FT
2 PUMPS 50 GPM EACH AGAINST 80LB
4"
6" MAIN LINE

Fig. 1. Diagram by F. J. H. showing general arrangement of his village water system

ELECTRICAL OPERATION IS AS MODERN AS POST WAR INDUSTRY MUST BE!



How HAYS Combustion Control

measures, coordinates, acts . . . AUTOMATICALLY

You ***See*** the **12 Vital Facts** of
MODERN COMBUSTION CONTROL
in HAYS SALES VISUAL

The most comprehensive, most understandable explanation of automatic combustion control ever compiled. Ask the Hays representative to show it to you.

1. The purpose of Combustion Control.
2. How that Purpose is accomplished—3 methods of control.
3. What results can be expected of each.
4. Elements of a ***good*** control system.
5. Elements of a good controller.
6. ***Coordinating*** the controllers.
7. Selecting the best system for your needs.
8. How Automatic Combustion Control operates.
9. How each individual controller operates.
10. How controllers are calibrated and adjusted to fit requirements.
11. How controllers are stabilized to prevent hunting or over-travel.
12. Typical installations of Automatic Combustion Control.

IT'S LIKE HAVING a smart, tireless four-man crew on the job—the boss (Master Pressure Controller) who waits for the call from the plant for more steam, then calls on the others to give him the necessary cooperation; the two men who control the Air (Air Flow Controller) and Fuel (Fuel Feed Controller) respectively; and the man who keeps the furnace draft constant (Furnace Draft Controller).

To a central panel come reports of every fluctuation in every combustion factor, to be recorded and measured. Instantly accurate impulses go from the Master Controller to the Air and Fuel Controllers. These subordinate controls in turn transmit their impulses instantaneously to the damper or air control device and to the fuel feed device. Thus steam generation is ***kept in practically perfect balance constantly.***

You can see the many advantages—big savings in man-hours, important cuts in fuel bills, greatly reduced maintenance. A big help in relating those benefits to your business is the Hays Visual Presentation of Automatic Combustion Control. A Hays Engineer can show it to you—no obligation, of course. A note to us will arrange it.

The HAYS CORPORATION
SINCE 1901
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

engine efficiency would be the actual mechanical energy delivered to the generator shaft, divided by the kinetic energy developed by a perfect nozzle.

Signed, WALTER HEIDECKER.

Answer No. 283

Why Is Water Level Hard to Control?

In the December, 1944 issue, G. B. stated that a new 300-hp, 4-drum bent-tube boiler had recently been installed in his plant and asked why the water level in this unit was hard to control as compared with the levels in two older cross-drum units already installed. All three units, he said, were equipped with the same type and make of feedwater regulator.

In the February, 1945 issue, Casper E. Hacker discussed the effects of swell and shrinkage on the water levels in this type of boiler, and in the March issue Walter Heidecker carried on the discussion of these two factors, illustrating his remarks with some sketches. Below are some comments by M. H. Kuhner on those sketches, showing why they are somewhat misleading and pointing out what really happens in this type of boiler and why.

Why Water Levels Must be Different in Drums of 4-Drum Boiler

THE ILLUSTRATIONS of a 4-drum bent tube boiler shown on page 122 of the March issue of POWER PLANT ENGINEERING are somewhat misleading. They show a water level of equal height in all three upper drums. This condition only exists while the boiler is standing idle and if no heat is applied, but with the boiler in service it is quite impossible for the water levels in upper front and rear drums to be at the same elevation as the water level in the center drum. The water column is connected to the center drum and the normal working water level is controlled from the level shown in the water gage.

Where an automatic feed water regulator is installed, the connections to the thermostat, generator or regulator float chamber are taken from the center drum. The operators have no indication of the water levels existing in front and rear drums while the boiler is in service and, unless they analyze what is going on in the boiler while it is steaming, they may be under the erroneous impression that the water level in front and rear drums corresponds with the level of the center drum which is shown by the water gage.

It must be realized that the front bank of boiler tubes connecting the front upper drum with the lower drum are exposed to highest gas temperature and radiant heat. Most steam generated by the boiler is formed in these tubes. The tubes therefore contain a mixture of steam and water which is discharged into the upper front drum and at higher ratings fills this drum entirely. The rear tube bank connecting the rear upper drum with the bottom drum of the boiler receives solid water only. The feed-water is fed to the rear upper drum and can enter the circulation only by flowing through the rear bank of tubes. Very little, if any, steam is formed in these tubes because the temperature of combustion gases passing over them is comparatively low and the feedwater accumulating in the rear tubes must first reach steaming temperature and absorb latent heat before steam can be formed. The intermediate tube bank connecting the center drum with the bottom drum of the boiler is exposed to medium gas temperatures. Steam is formed in these tubes but at a much lower rate than in the tubes of the first bank.

Because there is no connection between center drum and rear drum to permit water to circulate, the center tube bank and the rear tube bank form in effect two legs of a U-tube. If the water level is to be maintained in the center drum, the solid water contained in the rear bank must balance the steam-water mixture contained in the center bank and because the specific gravity of solid water is greater than that of a steam-water mixture, the height of the solid water column must be lower.

If we assume that the boiler is operating at 200 psig pressure and that the distance from working water level to center of lower drum is 20 ft, and if we further assume that the steam-water mixture contained in the center tube bank consists of 99 per cent water and 1 per cent steam by weight, we can calculate the approximate height of the column of solid water in the rear tube bank. The specific volume of water at the temperature corresponding with 200 psig steaming temperature is 0.018 cu ft per lb. This is 55.5 lb per cu ft. The specific volume of steam is 2.135 cu ft per lb, which is 0.468 lb per cu ft. One pound of the mixture will then be

$0.99 \times 0.018 = 0.0178$ water
$0.01 \times 2.135 = 0.02135$ steam

$1.00 \quad = 0.3915$ cu ft mixture.

This is 25.5 lb per cu ft.

A column one ft square, 20 ft high, consisting of 99 per cent water and 1 per cent steam by weight will then weigh 510 lb. To balance this column with a column of solid water we will have:

$$510 \div 55.5 = 9.2 \text{ ft.}$$

With the normal water level at the correct elevation in the center drum of the boiler, the level in the rear bank of tubes is therefore only 9.2 ft above the center of the lower drum. The upper part of the tubes and the entire rear drum of the boiler are filled with steam only.

In actual service of this boiler, the water level in the rear bank of tubes is usually found to be somewhat higher than the theoretical calculations indicate. Water gages connected to a water column extending through the entire height between upper and lower drums on boilers of the type illustrated, showed that at nominal rating the water level was only a few inches below the bottom of the rear drum. As the rating increased the water level continued to drop and was over 50 in. below the bottom of the rear drum at approximately 175 per cent of normal boiler rating.

I am attaching a sketch with which the U-tube analysis is illustrated. It would have been more correct if Figs. 2 and 3 on page 122 in the March issue had shown the front drums of the boiler entirely filled with a steam-water mixture and the rear drum entirely empty of water.

Worcester, Mass. M. H. KUHNER
Chief Mechanical Engineer
Riley Stoker Corporation

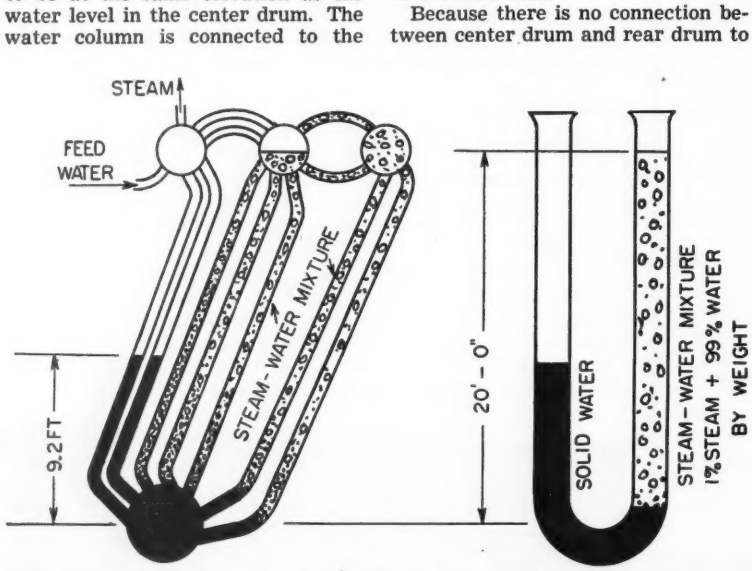
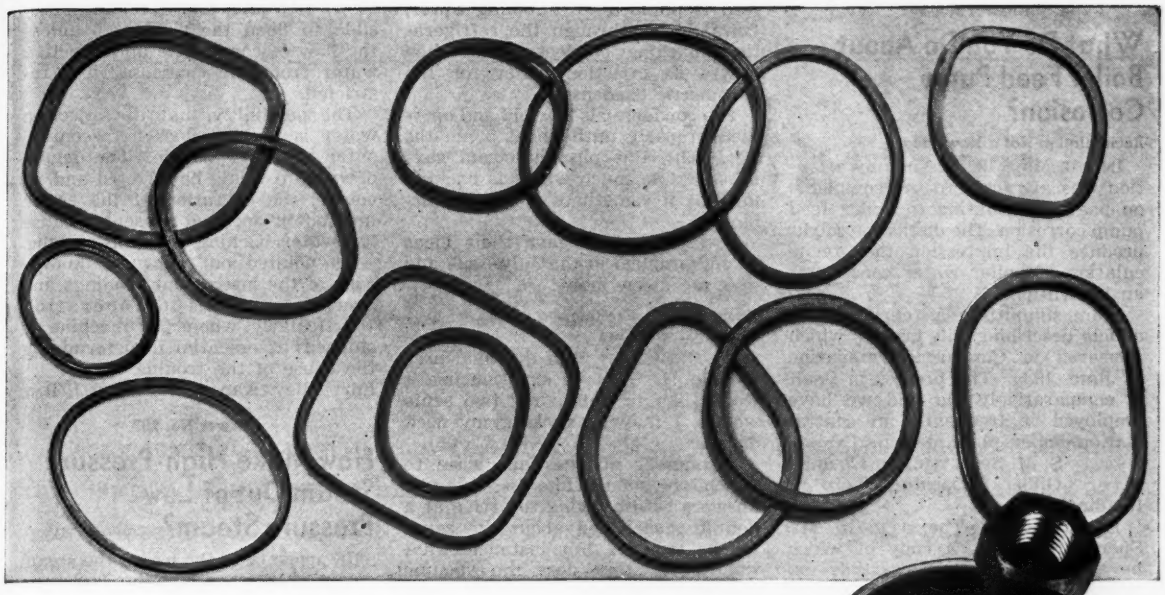


Diagram by M. H. Kuhner to show how difference between solid water and steam water mixture produces different levels in boiler drums



AJAX

"INSTALLED ECONOMY"

HIGH and LOW PRESSURE BOILER GASKETS

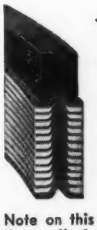
High speed production machinery and the quality of U. S. Gasket-engineering assures the consistent accuracy of AJAX Gaskets. Complete listing in Catalog 202.

Boiler "outage" held to minimum! Power, industrial and marine engineers confirm this direct result of installing AJAX Spiral Wound Gaskets in their manhole, handhole, tubecap and other boiler assemblies.

AJAX metal-asbestos boiler gaskets are available in these major pressure ranges — 0 to 499 lbs., 500 to 999 lbs., and 1000 lbs. up. Stainless steel is recommended for pressures over 500 lbs. — however, both construction materials and the number of spiral wound plies per diameter are determined by your particular service requirements or specifications.

AJAX Gaskets are easy to install and remove. They seal securely under a comparatively low bonding pressure, which eliminates excessive strain on fittings. The springback or "breathing" quality of AJAX Gaskets compensates for temperature and pressure fluctuations.

Assurance in service . . . trouble-free installations . . . these are true gasket economies, the economy of AJAX Spiral Wound Metal and Asbestos Gaskets.



★ **"THE STORY BEHIND THE GASKET THAT BREATHES"**

Note on this cutaway drawing, the small air space under each U-groove in the metal ply.

There are twin strips of asbestos filler between each spiral thickness in the AJAX Gasket which cannot meet in the center under the wedge-like groove. Therefore a "breather-space" is preserved in the heart of the gasket which assures its automatic reaction to mechanical compression, to internal pressure variation, and to temperature changes.

The AJAX Gasket expands and contracts — "breathes" — with changing pressure conditions — and retains the positive, secure seal you require at all times.

The above cutaway is the AJAX SR Compression Gauge Flange Gasket

SEE OUR CATALOG IN SWEET'S

Distributors in Principal Cities ★ ★ *A few choice industrial territories are open*

Write today for complete AJAX data—available in Catalog 202

Page 2H-8
Power Plant File

U. S. GASKET CO.

1596 PIERCE AVENUE, CAMDEN, NEW JERSEY

Answer No. 291

What Do You Do About Boiler Feed Pump Corrosion?

Recirculation Not a New Idea

IN THE May, 1945, issue, my attention was attracted to the comments on page 122 relating to boiler feed pump corrosion. The discussion might produce the impression that recirculation of boiler water constitutes an innovation.

I am submitting a reprint of an article describing this process which appeared in Combustion magazine in June, 1939. The process in itself is comparatively old and we have employed it frequently in central station boiler plant design.

S. M. SPERRY, Chief Chemist
Gilbert Associates, Inc.
Reading, Pa.

Editor's Note—The article Mr. Sperry refers to, a copy of which he sent us, is his own article entitled, The Recirculation of Boiler Salines. This is a detailed treatment of the subject, including discussion of feedwater pH correction, underlying theory, studies of recirculation in several plants and analysis of all the factors, copiously illustrated with curves and tables of data. Details of the equipment used to carry out the process are also given. The author shows how, by recirculation of 1 to 2 per cent of the boiler water, the hydrogen ion concentration of the boiler feedwater is corrected for the protection of economizers, feed pumps and feed piping without the introduction of additional chemicals.

Mr. Sperry has a few extra reprints of his article. As long as a supply is available, he says, he will be pleased to furnish copies to those interested. Write to him direct at Gilbert Associates, Inc., 412 Washington St., Reading, Pa.

We did not intend to produce the impression that recirculation of boiler water was an innovation, for we knew the procedure had been employed for some years. Our principal reason for referring to the article by Mr. Conlan in the February, 1944, issue was that it was the most recent review of the subject published in POWER PLANT ENGINEERING and we could supply a few extra tear sheets of it to those interested.

Answer No. 294

Why Is Barometric Condenser Water Backing Up?

IN THE April issue, H. G. S. asked what might be causing water to back up from a barometric condenser into a steam turbine. In the May issue, he amplified the information with a sketch showing how the turbine, a 225-hp, 6250-rpm unit, was connected to drive a centrifugal refrigerating compressor. The turbine steam supply is exhaust steam from other units. The condensate from the hot well is pumped to a cooling tower, flows thence through the refrigeration machine condenser and then serves as injection water for the barometric condenser.

The condenser is 2 yr old and operated properly until about 5 months ago. The tail pipe is clean, says H. G. S. So much water is backing up that it sometimes stops the turbine.

Several readers gave their ideas on the problem in the July issue and here are a few more:

Vacuum Gage Readings Should Give a Clue

IN CONNECTION with the condenser trouble H. G. S. is experiencing, I would like to put in my two cents worth. I may be sticking my neck out.

A number of questions arise to which one would like to have the answers before trying to arrive at a definite conclusion about the cause of the trouble. For instance, what kind of a story does the vacuum gage tell? What disposition is made of the exhaust pipe drain and what equipment is used to drain it? What about the quality of the steam entering the turbine?

There are other questions, of course, but it does seem that the vacuum gage would indicate—and pretty definitely—the nature of the trouble. Remembering the unit operated properly for 19 months, it seems reasonable to rule out the possibility of faulty design and to assume the difficulty due to locally developed trouble.

It is my opinion that: (1) water is being siphoned into the turbine or exhaust line through faulty drainage equipment; (2) the drainage equipment is not removing the condensate; or (3) slugs of water are entering the turbine at the steam end. It is obvious water could not rise to the exhaust inlet of the condenser since atmospheric pressure will not sustain a column of water higher than 34 ft. It would, therefore, be impossible to flood the condenser unless the flow of condensate and injection water from the condenser was restricted.

The possibility that the injection water is too hot does not seem to enter into this trouble. The degree of vacuum would be affected and, of course, the operation of the entire unit but it does not present a cause for water backing into the turbine.

As pointed out above, a knowledge of the instrument readings and general conditions of operation (particularly when the machine is slugged) is essential in determining the cause of the trouble.

Fort Riley, Kansas CLOYD J. RAY

Answer No. 297

How Make High-Pressure Steam Out of Low-Pressure Steam?

IN ADDITION to the use of the steam compressor, on which he had seen some data, what other methods are there, asked L. C. D. in June, for producing a small quantity of high pressure process steam in his plant. The steam generated was only about 150 hp at low pressure for building heating.

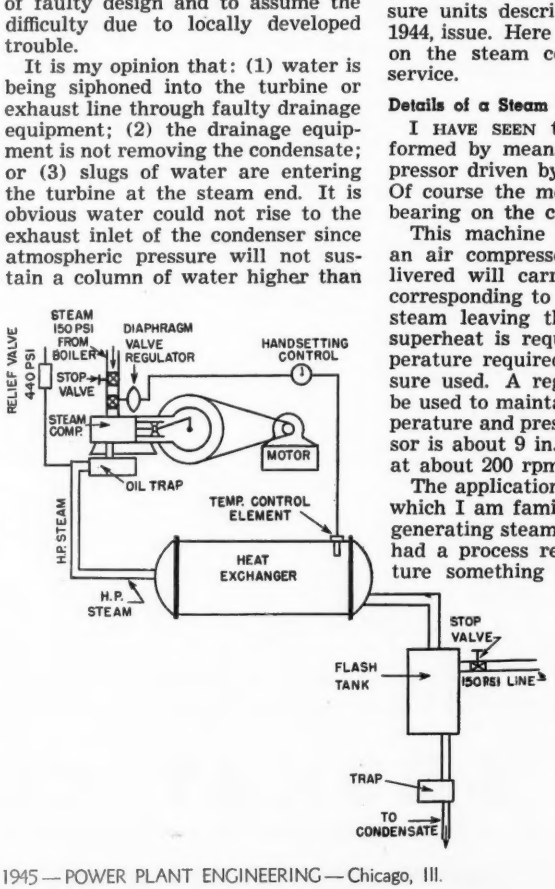
We commented first on the use of the thermo-compressor and then called attention to the possibility of generating this steam directly from fuel in one of the small high pressure units described in the August, 1944, issue. Here are some comments on the steam compressor for this service.

Details of a Steam Compressor

I HAVE SEEN this operation performed by means of a steam compressor driven by an electric motor. Of course the motive power has no bearing on the case.

This machine is very much like an air compressor. The steam delivered will carry the temperature corresponding to the pressure of the steam leaving the compressor. No superheat is required and the temperature required dictates the pressure used. A regulating device can be used to maintain the desired temperature and pressure. The compressor is about 9 in. by 12 in. and runs at about 200 rpm.

The application of this device with which I am familiar was in a plant generating steam at 150 psi and they had a process requiring a temperature something over 400 F. They



Sketch by W. J. of steam compressor arrangement for raising pressure of steam for an industrial process

Where an inhibition frees tubes of trouble

Condenser tubes in a Liberty ship were failing after only 2 months of service. Inlet and outlet water temperatures were 83°F. and 103°F., with inlet steam temperature at 126°F. The outside surfaces showed a uniform oxide film. Inside, the cooling water had laid down a brown coating of iron oxides. Preliminary examination revealed nothing as to the cause, and samples were turned over to a Scovill engineer for thorough examination.

Laboratory inspection revealed green and white corrosion products in deep pits at several areas of the inside surface. In the bottoms of the pits redeposited porous copper was found.

REDEPOSITED COPPER GIVES CLUE

Scovill identified the trouble as "plug type dezincification," an electro-chemical corrosion which dissolves the metal and redeposits brittle copper. The condenser had been tubed with Aluminum Brass without an inhibiting agent. As recommended by Scovill, at the next retubing this condenser was fitted with Aluminum Brass tubes containing 0.04% to 0.05% of an inhibiting agent and normal tube life was obtained.

THREE SCOVILL SERVICES

Scovill *Service in Men* provides specialized advice and study on individual tube problems, as in the example above, and on installation practice. Scovill also provides two other services. *Service in Metals* includes the selection of alloys and the study, in the laboratory and in the field, of specific problems for individual customers. *Service in Manuals* offers valuable literature on condenser and heat exchanger tubes. To get your copy of our Condenser Tube Booklet, address Scovill Manufacturing Company, 17 Mill Street, Waterbury 91, Conn.

Scovill
MANUFACTURING COMPANY
WATERBURY 91, CONN.

CONDENSER TUBES
ONE PRODUCT . . . THREE SERVICES
Service in Manuals . . . Service in Metals . . . Service in Men

could set the control valve at the required temperature and the machine would deliver steam at corresponding pressure. I believe the relief valve in this case was set at 450 psi. The sketch shows the general arrangement.

The operation was quite simple and required a minimum of attention. The return on the high pressure line was piped through a flash tank back into the 150 psi line.

W. J.

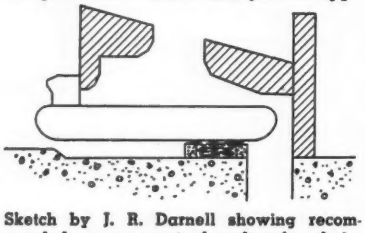
Answer No. 298

What Types of Boilers and Stokers Should They Choose?

Select Water-tube Boiler and Chain-grate Stoker

To PRODUCE process steam at a rate of approximately 500 bhp per hour when burning coal of about 10,000-Btu per pound, I would unquestionably select a forced draft type of traveling grate stoker installed under a horizontal water-tube boiler.

Coal of 10,000-Btu per pound as fired usually will have an ash content even higher than 12 per cent, sometimes as high as 14 per cent, and the fusion point of the ash may be quite low. Such analysis is typical of many mid-western coals such as those of Iowa, Illinois, Indiana and Western Kentucky.



Sketch by J. R. Darnell showing recommended arrangement of arches for chain-grate stoker and horizontal water-tube boiler advocated for conditions of Question No. 298

As pointed out in Chapter XII of my Boiler Fireman's Handbook, appearing in the July issue, either natural-draft chain grates or forced-draft traveling grate stokers are ideal for coals having high ash with low fusion point, since there is no agitation or disturbance of the fuel bed and consequently clinker formation is reduced to a minimum.

The sketch illustrates a recommended arrangement of arches with a horizontal water-tube boiler set about 12 ft from the floor to the bottom of the front header.

There may be quite a debate as to the choice of boilers among proponents of the various types such as horizontal or vertical water-tube, or HRT designs. A Scotch marine boiler would be out of the question with a traveling grate stoker. A horizontal water-tube type can be installed with less trouble with baffle repairs than the vertical types and will have somewhat lower flue gas temperature.

If O. B. desires any detailed information as to specifications for the proposed boiler, stoker and auxiliary equipment, I shall be pleased to assist him.

Naperville, Ill. J. R. DARNELL

Answer No. 299

What Sucks the Water Out of the Bucket?

Absorption, Aspiration, Vacuum Could Explain It, Says Holman

JKR PRESENTS a very interesting problem in the June PE&E section. I would like to comment on it.

There are three possible ways in which water from the purge bucket might enter an ammonia refrigeration system:

1. Absorption:—if the air is blown out of the purging hose by ammonia vapor, and the purge valve throttled to a slight seepage past the seat, the ammonia may be absorbed by the water faster than it passes through the valve. Since ammonia in water occupies less space than the same quantity of vapor at atmospheric pressure, a partial vacuum is slowly created in the hose. The pressure of the atmosphere forces the water into this partial vacuum. This would be impossible with the purge valve well opened, and with the condenser under reasonably high pressure.

2. Aspiration:—If the purge line taps into the condenser near the vapor inlet, as in Fig. 1, the velocity of the vapor could create a partial vacuum on the same order as that of a steam injector. This would require compressor operation to set up and maintain vapor velocity, and compressors are not normally operated when purging.

3. Vacuum:—This is the most likely method, and may occur as follows. At the close of the day's run, the expansion valve or master liquid stop valve is closed, and the system pumped down to, say, 20 in. vacuum. This may be intentional, or due to a gage reading too high. The compressor is then stopped, the manifold valves closed and the valves V-L and V-E in the liquid and equalizer lines closed to trap most of the refrigerant as liquid in the receiver. Figure 2 shows where these valves are in the system.

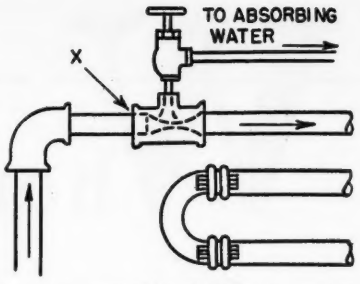


Fig. 1. Venturi tube effect at tee purging connection when compressor is operating; especially possible if pipe entering tee at X has not been reamed, says George Holman

If the compressor valves should leak, the vapor in the condenser would leak back into the evaporators and the pressures would equalize. If the discharge gage were connected to the receiver space as shown, instead of to the condenser, such leakage would not be noticed.

It is not at all unusual for a direct expansion, natural circulation system to have evaporator volume 10 times that of its atmospheric condenser. With high vacuum in the former and low original pressure in the latter, equalization of pressures may leave both below that of the atmosphere. Any attempt to purge would result in the water being drawn into the system.

Marissa, Ill. GEORGE HOLMAN

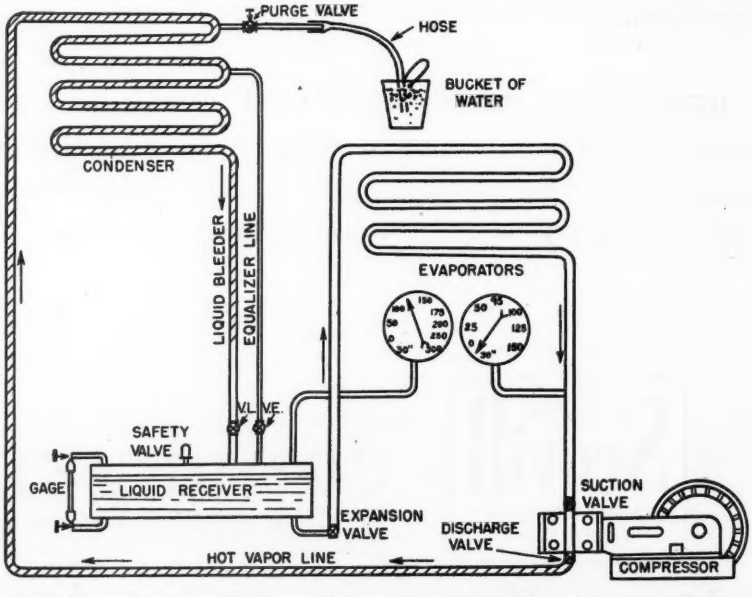


Fig. 2. Schematic diagram by George Holman of complete refrigeration system, showing how evaporative condenser is purged

VIOLENT LOAD SWINGS

✓ CHECK THIS "INSIDE" STORY OF SAFETY

MEMO TO: *Operators of High-Duty Steam Generators*
SUBJECT: *Safe Operation Under Emergency Conditions*

Ever have enough of your transmission lines go down to knock your high-pressure topping turbine off the line? Ever have your loads swing violently over a range in which peak load was 18 times minimum -- in which drum pressure surged between limits 700 pounds apart? Then you know what it is to face real emergency conditions.

So does the COPES Flowmatic. The heavy storms of last winter placed unusual demands on many steam generators equipped with this modern two-element feed water control. In every case the Flowmatic held the boiler water level within safe limits -- even under the extreme conditions cited above.

For security reasons, the story of what happened in this plant cannot be published now. But if you'd like to know how closely water level can be stabilized when hell pops loose, ask the COPES man to tell you the inside story of this installation. Write, and we'll have him call.

NORTHERN EQUIPMENT COMPANY · *852 Grove Drive, Erie, Pa.*

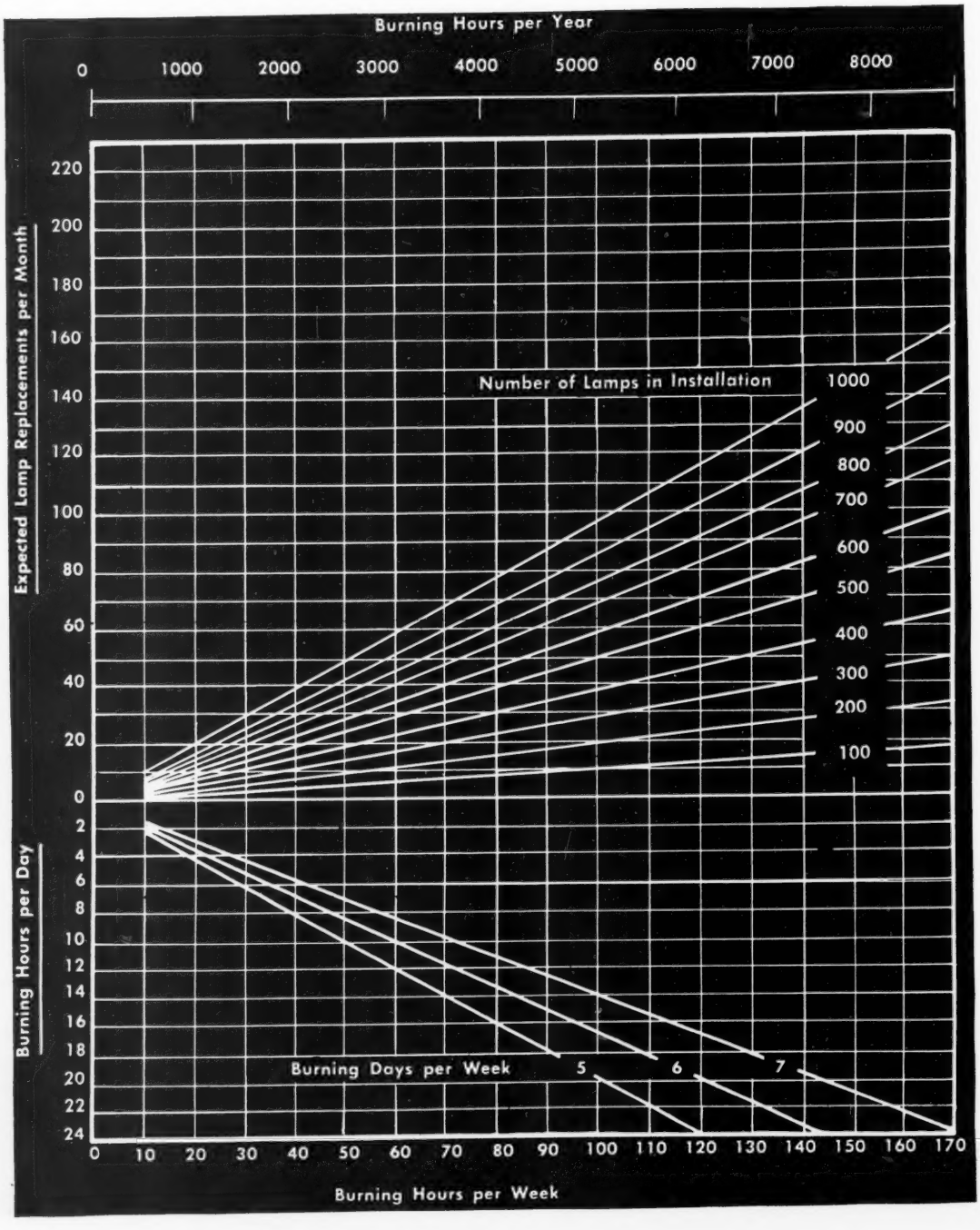
FEED WATER REGULATORS • PUMP GOVERNORS • LIQUID LEVEL CONTROLS • DIFFERENTIAL VALVES • REDUCING VALVES & DESUPERHEATERS

BRANCH PLANTS IN CANADA AND ENGLAND — REPRESENTATIVES EVERYWHERE

☆ *For* **SAFETY** *and* **ECONOMY** *Specify*

COPES

Chart for Determining Expected Fluorescent Lamp Replacements Per Month



This chart is based on a rated average lamp life of 4500 hours.

Note.—Next month a similar chart will be presented, based on a lamp life of 6000 hours

Presented by courtesy, Sylvania Electric Products Co.

MORE HAULS, FEWER OVERHAULS

SUN DIESEL LUBRICANT . . .

Eliminates Carbon Troubles, Weekly Overhauls; Boosts Towboat Operating-Time

Stop . . . start . . . run for fifteen minutes . . . and stop again. Those were the operating-conditions of a big steel mill's Diesel towboat.

The result? Carbon built up in the head. Exhaust-ports had to be cleaned every week. Rings stuck. A general overhaul was scheduled every six weeks.

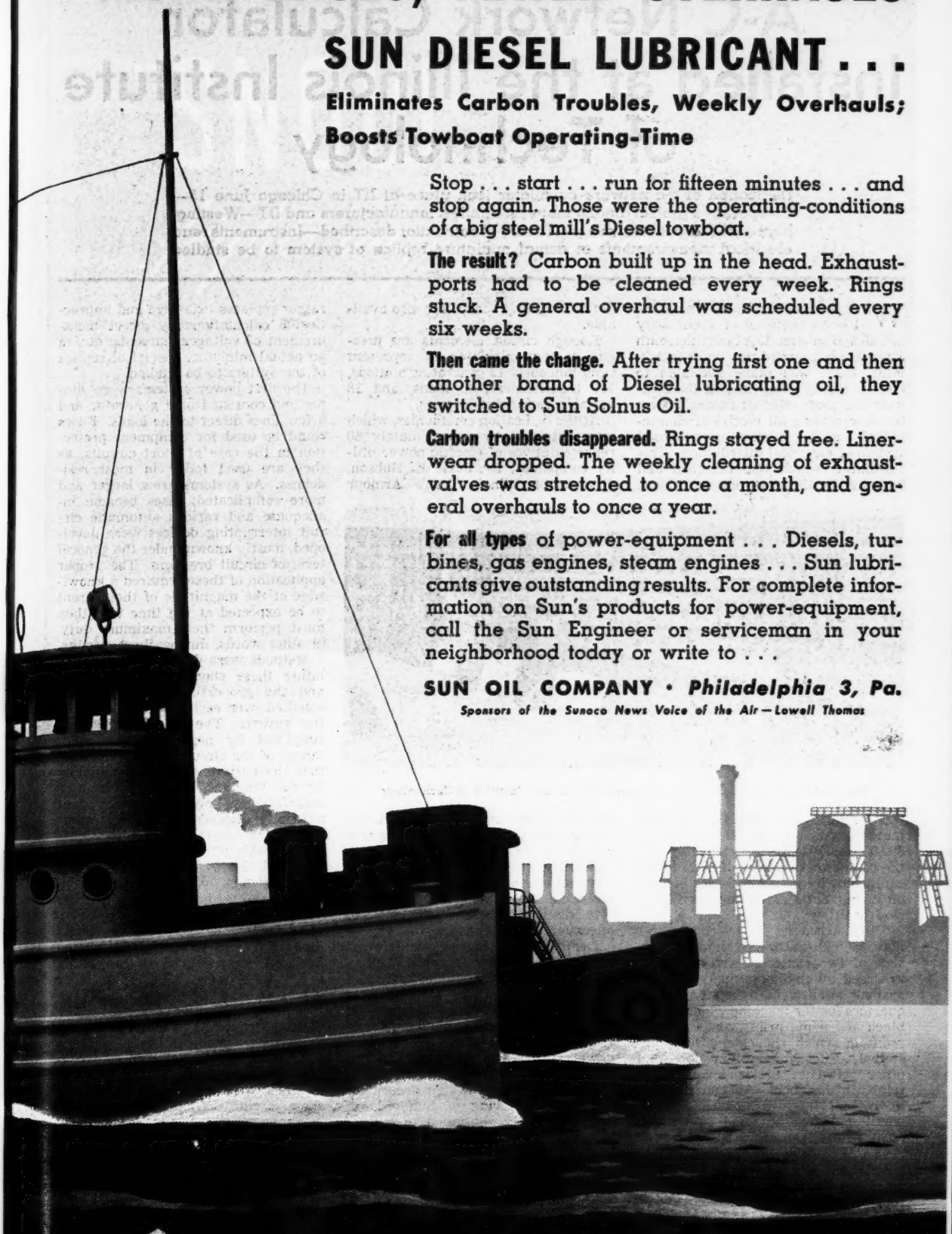
Then came the change. After trying first one and then another brand of Diesel lubricating oil, they switched to Sun Solnus Oil.

Carbon troubles disappeared. Rings stayed free. Liner-wear dropped. The weekly cleaning of exhaust-valves was stretched to once a month, and general overhauls to once a year.

For all types of power-equipment . . . Diesels, turbines, gas engines, steam engines . . . Sun lubricants give outstanding results. For complete information on Sun's products for power-equipment, call the Sun Engineer or serviceman in your neighborhood today or write to . . .

SUN OIL COMPANY • *Philadelphia 3, Pa.*

Sponsors of the Sunoco News Voice of the Air—Lowell Thomas



SUNOCO

SUN INDUSTRIAL PRODUCTS

OILS FOR AMERICAN INDUSTRY

A-C Network Calculator Installed at the Illinois Institute of Technology

Dedication of a-c network calculator took place at IIT in Chicago June 15—Co-operative project among midwest utilities, manufacturers and IIT—Westinghouse establishes fellowship—Theory of calculator described—Instruments read electrical measurements of actual miniature replica of system to be studied

WITH THE official dedication at the Illinois Institute of Technology in Chicago on June 15, of the thirteenth alternating current net work calculator, there was made available to electric utility companies in the Midwest the most efficient means known for determining all electrical characteristics of an existing or proposed system of electrical distribution. This calculator, which was designed and built by Westinghouse Electric Corp., was installed in a specially designed laboratory at an approximate cost of $90,000 and was made possible through the co-operative efforts of 17 Midwest companies by their purchases of time on a unit basis extending over a period of 12 yr.

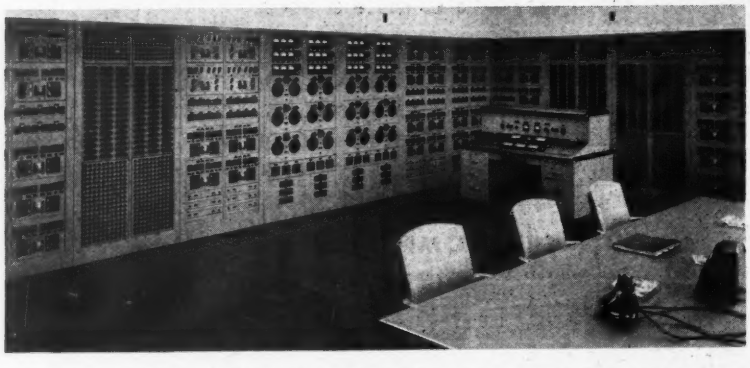


Fig. 1. A-C Network Calculator in laboratory at Illinois Institute of Technology

The laboratory in which the a-c network calculator is contained consists of two conference rooms which are used by engineers making power system studies, a reception room, quarters for the machine which makes black and white prints, and the large room in which the calculator is installed. Files for system data and other reference material are maintained in this room. Air conditioning, fluorescent lighting, and plate glass partitions offer practical as well as comfortable laboratory space.

The calculating board itself is composed of 12 metal cabinet sections, covering 40 ft of wall space. Each section is 7 ft high and 38 in. wide. Controlling the board is the metering desk which contains the instruments for accurate measurements. Two small d-c caluculating boards are also available.

Enough circuit elements are present in the calculator to represent simultaneously 12 generating stations, 100 transformers, 40 loads, and 18 variable ratio transformers.

At the dedication ceremonies, which were attended by approximately 60 representatives of electric power utility companies, Dr. Jesse E. Hobson, director of Illinois Tech's Armour Research Foundation, spoke on the background and usefulness of the new calculator while Dr. W. A. Lewis, consulting electrical engineer at the Foundation and research professor of electrical engineering at the Institute, discussed the management and operation of the board.

Demonstration of the calculator at work was given by Lester B. LeVesconte, supervisor of studies and chief engineer in charge of all calculator studies. This network calculator is so designed that it can duplicate electrically any existing or proposed power system in the world, and can solve difficult problems in power system operation and design accurately and with a saving of hundreds of hours formerly consumed in mathematical computations.

Theory of Calculator

In his discussion of the theory of the calculator, from which the following paragraphs are quoted, Mr. LeVesconte pointed out that the a-c Network Calculator does not calculate in the mathematical sense, but rather replaces extensive and impracticable calculations by direct measurement of voltages, currents, etc. in an actual miniature electrical replica of the system to be studied.

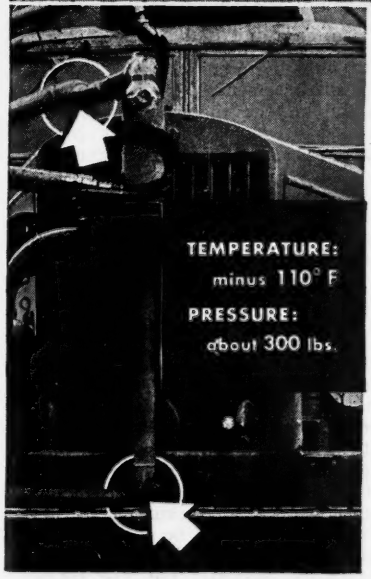
The first power systems were simple and consisted of a generator and a few lines direct to the loads. Fuses could be used for equipment protection in the case of short circuits, as they are used today in most residences. As systems grew larger and more complicated, fuses became inadequate and various automatic circuit interrupting devices were developed, mostly known under the general term of circuit breakers. The proper application of these required a knowledge of the magnitude of the current to be expected at the time that they must perform their maximum duty, in other words, during short circuits.

Methods were developed for calculating these short circuits currents and the proportion of the current supplied over each line or circuit on the system. The calculations were simplified by neglecting the resistances of the circuits and considering that the current was limited mainly by the reactance of the generators, transformers, lines, etc. The current naturally divided in inverse proportion to the reactance.

Considering this, it was not difficult to design an assembly of adjustable resistors which could be connected in any combination, with some means of measuring the current in each resistor. These resistors could then be connected in the same manner as the reactances of the system to be studied and adjusted to have values equivalent to these reactances.

With the positive terminal of a direct current source connected to all the resistors representing generators, the negative terminal could be connected to any point on the network at which it was desired to know the short circuit current. The resultant currents in the resistors would be proportional to the total short circuit current as well as the current in every circuit and with proper multipliers would indicate the system current in amperes. Probably because this took the place of considerable calculations, this device was called a d-c calculating board.

"SNOW" fights airplane fires



WHEN this Cardox Airport Fire Truck roars up and releases a mass discharge of *tons* of carbon dioxide "snow" (dry ice) and carbon dioxide vapor at minus 110° F., at pressure of about 300 pounds per square inch — plus hundreds of gallons of fire-blanketing foam—crash fires usually die fast.

Such service calls for the extra strength and reliability of Tube-Turn welding fittings. Their smooth interiors make for maximum efficiency of flow, help in assuring fast, dependable action.

Many equipment manufacturers are discovering what piping engineers have long known—that Tube-Turn welding fittings offer exclusive advantages in any use where piping efficiency is a factor. Tube Turns engineers will be glad to consider your individual problem, without obligation.

• • •

Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

TUBE TURN (Inc.), Louisville 1, Kentucky. Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle, Los Angeles.

TUBE-TURN TRADE MARK *Welding Fittings and Flanges*

Complications Demand Calculators

Power systems continued to grow, and with the growth came additional and more complex problems such as load division and voltage regulation in involved networks and stability between large inter-connected generating stations. The proper representation of these conditions in a miniature setup required a representation of the phase angle of the impedance, power source, etc. This demand was finally met about 1929 when some devices were developed using alternating current for power instead of direct current and arranged to represent reactances, resistances, and capacitances as well as the phase angle between the power source. It was natural that they should be called a-c calculating boards. The further perfected and modern version of this equipment is now known as the a-c Network Calculator.

By using the method of symmetrical components, three phase systems are represented on a single phase basis, each section of a three-phase transmission line or circuit being represented by a single resistor-reactor circuit on the calculator. In order to reduce the physical size of the reactors and condensors, the calculator is designed to use a frequency of 440 cycles, which does not complicate any setup since all units are calibrated in ohms.

The most general type of circuit contains a resistor adjustable from 0 to 399-ohms in series with a reactor adjustable from 0 to 300-ohms. There are 100 of these line circuits and they are used to represent impedances of transmission lines, series impedance of transformers, and all general series impedances of the system.

Loads are also represented by impedances, but since they are connected in shunt, the impedance values are much higher than the series impedances used for the lines. For this purpose there are 40 load circuits with a resistance range of 0 to 3990-ohms and a reactance range of 0 to 2400-ohms. For convenience in calculating and setting these circuits, the resistance and reactance can be connected either in series or in parallel. There is one difference between the operation of the load circuits on the calculator and the actual loads on the power systems. The load taken by one of these circuits will vary as the square of the voltage, while the load on the actual system is not so much affected by the system voltage. To correct for this difference, each load circuit includes a tapped autotransformer, called a load adjustor, by which the load can be maintained easily at the desired value.

Indication of Capacitance

The capacity of long, high-voltage transmission lines cannot be neglected, and this is represented on the calculator in the form of the equivalent pi circuit, that is, half of the total capacitance is represented at each end of the line. Since several lines usually are connected to a common point, all of the capacitance to be represented at that station is combined into a single capacitor connected to the bus. Thirty-six adjustable capacitor circuits are available for this purpose, or for use wherever a capacitor circuit must be represented.

Most transformers can be represented by the series impedance reduced to a common voltage or kva base. Whenever the transformers are a part of the closed loop on the system, the exact ratio of all transformers around the loop may not be the same as the voltage ratings picked for determining the base. To make up this difference there are 18 variable ratio auto-transformer circuits adjustable in 0.5 per cent steps over a range of $\pm$ 10 per cent.

In most cases where it is necessary to represent mutual impedances between transmission lines, this can be done by a special connection of the line circuits. For those cases in which this simple connection is not possible, there are 18 low-leakage, mutual transformers available. Also, there are a number of metered and unmetered jumper circuits for use where a connection without impedance is needed.

Separate Unit for Each Power Station

Instead of using a single source of power, as is done on the d-c calculating board, the a-c Network Calculator requires a separate unit for each power station to be represented. These units are actually phase shifters, energized from a common three-phase source, and arranged to provide a single phase output adjustable for any phase angle and any voltage magnitude from 0 to 400-v. There are 12 such power sources, each one equipped with a special low-resistance reactor circuit to represent the internal reactance of the generating station. For each one there is also a set of instruments to give an approximate indication of the voltage, current, and power of the circuit.

In order to represent all types of networks or power systems, means must be provided to connect the above circuits in any desired combination. On this calculator three plug boards are provided for this purpose, each having 96 pairs of plugs and 25 rows of receptacles. Each pair of plugs is terminal of one of the above circuits, the number of which is marked on the panel between the plugs and also on the back end of each plug for easy identification. The receptacles are connected so that all plugs in adjacent receptacles are connected together. Therefore, to connect any two terminals together it is only necessary to insert them in the adjacent receptacles anywhere on the panel. Sometimes it is necessary to make a connection between a plug on one board and a plug on another board. For this purpose the receptacle at the right-hand end of each row on each board is connected to the corresponding receptacle on each of the other boards. Likewise the left-hand ends

Fig. 2. Lester B. LeVesconte performing desk operations on the A-C Network Calculator

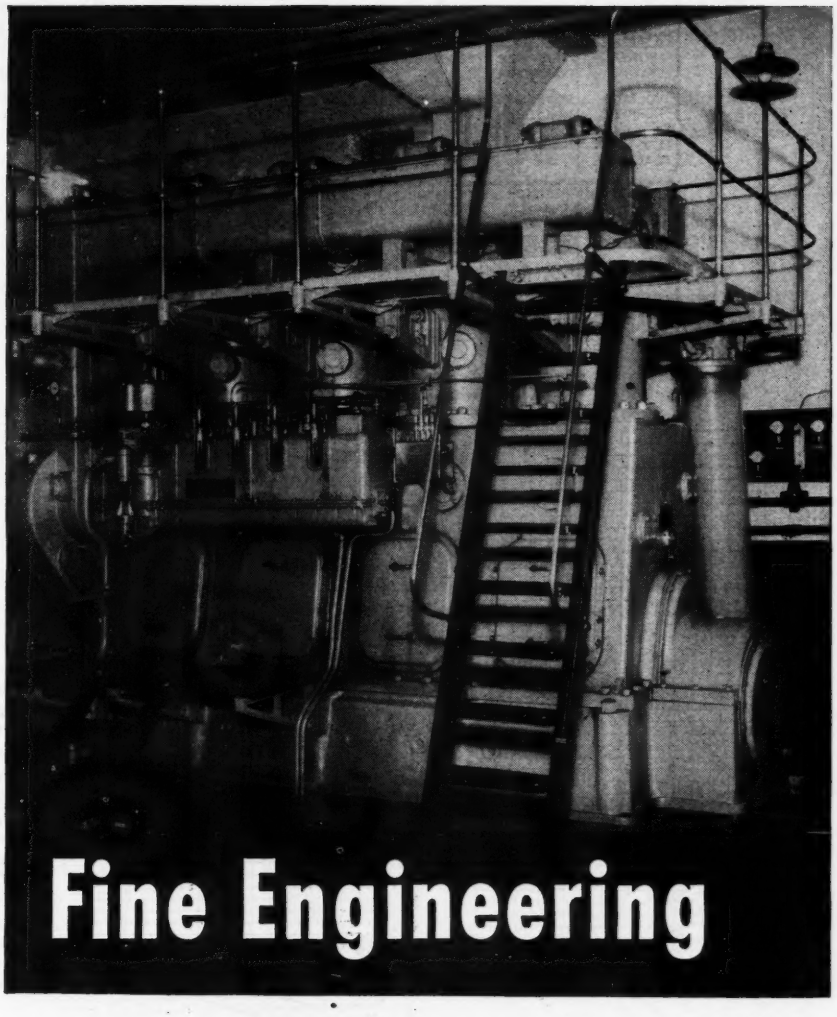
are also connected. In this way a plug in one of these end receptacles on one board is actually connected to the corresponding end receptacle on each of the other plug boards. In the row immediately below the plugs the receptacles are all connected together and form a system neutral from which all voltage sources originate and to which all shunt loads, shunt capacitors, and faults are connected.

Main Metering Desk

Separate from the cabinets along the wall (but connected electrically through a trench) is the main metering desk at which all accurate measurements are made. A metering bus of No. 7 wire is run from the metering desk and extends over the entire assembly of cabinets. In the cabinets each circuit is provided with a small relay arranged to connect that circuit to the metering bus. These relays are energized selectively by a circuit selector on the metering desk, controlled by a set of buttons conveniently located near the right-hand end of the meter desk panel. Thus, by the manipulation of a few buttons on the meter desk, the operator can connect his accurate instruments to any circuit of the calculator.

On the meter desk there are two independent sets of instruments. Along the lower edge of the meter panel is a set of three instruments for reading scaler values of amperes, volts, and watts or vars. These are standard torque instruments, but they are operated through thermionic negative-feed back amplifiers so that the actual burden on the network is very small. Convenient switches permit selecting the most suitable scales. The volt meter can be connected for full scale readings of 125 or 250-v, while the ammeter has five ranges with full scale readings of 6, 2, 0.6, 0.2, and 0.06-amp. The watt-var meter is used to read either watts or vars with scales to match scales selected for the ammeter and voltmeter. The figures on the watt-var meter scales can be arranged to be some multiple of ten times the kva base chosen for the study so that the values can be read directly in terms of

Every Baldwin Diesel rests on a Foundation of Fine Engineering



What a municipal power plant needs most in a diesel engine is dependability.

Baldwin Diesels are engineered and manufactured with that thought in mind. Every proven new development that can contribute to complete dependability, high efficiency, and continuous trouble-free service has been included. One important modern feature is the chrome-plated liner, which multiplies liner life many times, and eliminates ring difficulties.

When you are modernizing or expanding your installation, let us tell you what Baldwin Diesels can offer in the way of plant economy and improved performance.

The Baldwin Locomotive Works, Locomotive & Ordnance Division, Philadelphia 42, Pa. Offices: Philadelphia, Chicago, St. Louis, Washington, New York, Boston, San Francisco, Houston, Cleveland, Detroit, Pittsburgh.

BALDWIN PRODUCTS

Locomotives, Hydraulic presses, Testing equipment, Steel forgings and castings, Diesel engines, Metal plate fabrication, Rolled steel rings, Bronze castings, Ship propellers, Marine steering gear, Heavy machine work, Crane wheels, Bending rolls, Plate planers, Babbitt metal, Alloy iron castings, Briquetting presses.

BLW THE BALDWIN GROUP

BALDWIN

DIESEL ENGINES

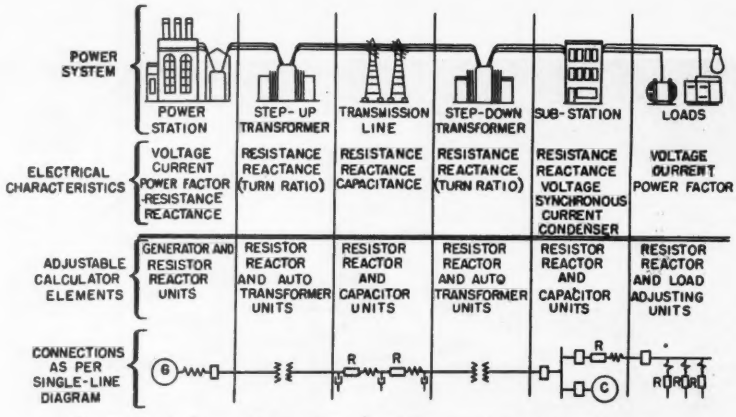


Fig. 3. Typical network circuit the problems of which are solved by the A-C Network Calculator

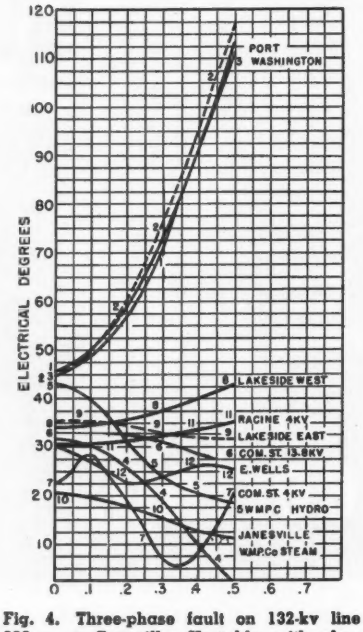


Fig. 4. Three-phase fault on 132-kv line 555-w at Granville—Unstable with slow relaying

system values, such as kilowatts or megavars.

Reading Vector Values

The second set of instruments located just above the scaler instruments consists of a voltmeter and ammeter used for reading vector values. A standardizing current, adjustable to any phase position, is taken from a phase shifter, energized from the same three-phase source as the power sources of the network. The voltmeter will read the voltage in phase with this standardizing current or the voltage in quadrature with it. The ammeter likewise will read the components of current in phase with or in quadrature with the standardizing current. To determine the exact phase angle of any voltage, the shifter is turned until the quadrature standardizing current results in a zero reading on the voltmeter. Then the phase angle reading is taken from the dial of the phase shifter, which is located conveniently between the ammeter and voltmeter.

In the most common use of the equipment, engineers of the participating companies will assemble complete data on the system to be studied, including impedances of all circuits, voltages at various points, power being generated by all generating stations, and the magnitude and power factor of all loads. All of this information is reduced to calculator values. The circuits on the calculator

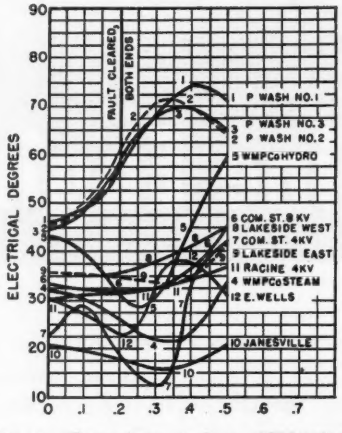


Fig. 5. Three-phase fault on 132-kv line 555-w at Granville—Fault cleared by opening both ends of line in 0.2 sec—Stable

are then connected in the same manner as the generators, lines, transformers, loads, etc., on the power system and adjusted to have equivalent characteristics.

When all of the known system operating conditions are matched by values on the calculator, which can be read accurately at the meter desk, the entire setup is a correct representation of the power system. The voltages and loads on all circuits of the calculator can be measured accurately, giving information not otherwise readily available because measuring equipment is not usually available at all points on the power system. Changes can then be made, new lines added, new loads served, new generators put into operation, etc., and again accurate measurements can be made at all points to predict the effects of such changes.

Transient studies can be made by using a step-by-step process, using the readings of one step to calculate the conditions that must be met on the following step. Less common, but very important to power systems, is the study of transient voltages that last only a cycle or two. These studies are made by reproducing the characteristics of the system on the calculator circuits and repeating the application of the transient rapidly enough by means of commutators so that the voltage wave can be observed on an oscilloscope.

Besides power system studies there are several other uses for the calculator. In some complicated problems of mechanical stresses, heat flow, and accustics, the elements can be translated into terms of electrical equivalents and the resulting electrical system can be studied on the calculator. The extent of the possibilities in this direction has not yet been fully explored.

Westinghouse Fellowship

Announcement was made during the dedication ceremonies that the Westinghouse Electric Corp. has recently established a co-operative fellowship at Illinois Tech which is available to graduates of recognized electrical engineering schools, provides work on the a-c network calculator as part of the training program

ARMOUR RESEARCH FOUNDATION — ILLINOIS INSTITUTE OF TECHNOLOGY

POWER SYSTEMS ENGINEERING LABORATORIES — NETWORK CALCULATOR

STABILITY CALCULATION SHEET

Inertia, WK^2 _____ ft^2 Generator _____ Page No. _____

Kinetic Energy (KE_{KVS}) _____ MV Sec Study for _____ Study No. _____

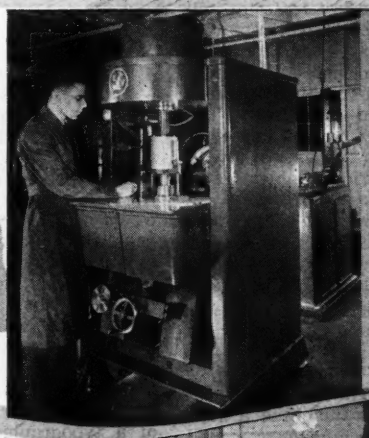
K = Acceleration Constant _____ °/Sec²/MV Condition _____ Date _____

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Time	Initial Phase Angle θ	Internal Voltage	Power Input to Rotor	ΔP	$K\Delta P$	Δt_{sec}	$\Delta\omega = K\Delta P\Delta t_{sec}$	$\omega_{AVE} = \sum\Delta\omega$	Δt_{ω}	$\Delta\theta = \omega_{AVE}\Delta t$	$\theta = \sum\Delta\theta$		
-0													
			Power Output to System	Input Minus Output	Acceler-ation	Accel. Time Incre.	Velocity Change	Average Velocity	Velocity Time Incre.	Change in Angle	Final Angle	Calc. by	Ckd. by
+0													

Fig. 6. Form of calculation sheet used with Network Calculator

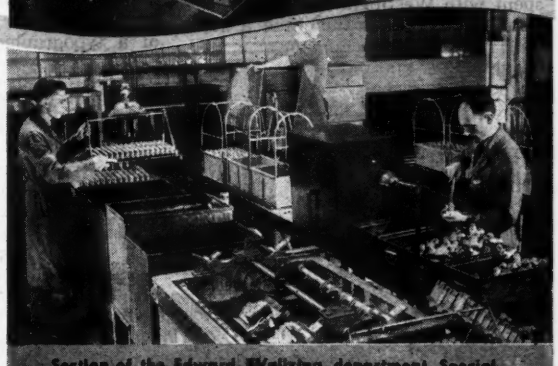
HOW EVALIZING* CUTS VALVE WEAR, GALLING AND FREEZING

PROBLEM: In practically all steel valves there are some steel parts which must turn or slide freely in contact with other steel parts. But in many services, frequent operation, wide temperature and pressure variations and other factors result in wear and galling or binding between the parts. Operation of the valve becomes difficult.



In special machines, built to Edward designs, Edward engineers have tested thousands of metal specimens for wear and galling or seizing characteristics. Electric furnaces make possible elevated temperature tests when desired. The general problem of abrasion has been under study in the Edward laboratories on such equipment for decades.

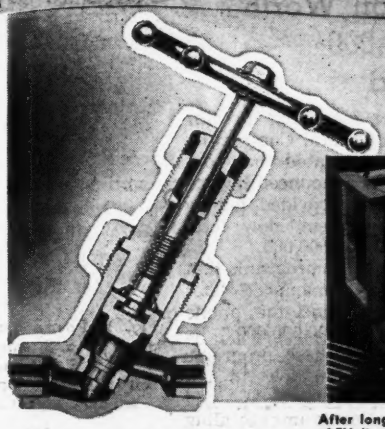
SOLUTION: One Edward answer to abrasion is EValizing,* an exclusively Edward process for coating steel valve parts with a bearing material which reduces friction between moving steel parts by about 25 per cent. It is applied electrolytically to such parts as the internal stem threads of all inside screw forged steel valve bonnets, junk rings, packing nuts, and, in the case of large high temperature, high pressure valves, the nuts used in body-bonnet bolting.



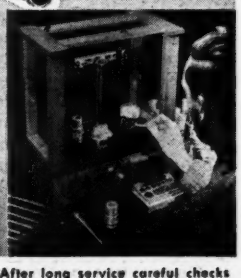
Section of the Edward EValizing department. Special fixtures permit plating of inside screw threads.

RESULT: Edward makes wide use of EValizing and the dividends are in much longer valve life and easier valve operation. For instance, long time tests show that a stainless steel stem can be rotated nearly 1000 per cent more in an EValized bonnet than an ordinary unprocessed steel bonnet. EValizing is a standard feature for many Edward valve parts, and is especially important on such valves as Fig. 2698 forged steel globe valve, right. Built in ¼ in. to 2 in. sizes, screwed or welding ends, and with a companion angle design, this low-cost, all-purpose valve is ideal for a multitude of services.

*Trade-Mark Registered



Widely used Edward Fig. 2698 forged steel stop valves showing areas regularly EValized.



After long service careful checks of EValized and non-EValized bonnets have been made. Loss in weight due to wear in Evalized bonnet approximates ½ that of normal untreated steel bonnet.

EDWARD *Steel* VALVES

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO, INDIANA

Look to Edward for the Best in New Steel Valve Developments

in addition to a 12-month course in power system design and operation.

The grant of $3,000 to be applied over three semesters of study includes $125 a month to the recipient of the fellowship, all tuition fees, and a fund for the purchase of equipment and supplies for the research project to be undertaken by the fellow.

Work during the first semester will consist of graduate courses in mathematics, symmetrical components, power transmission, and related subjects. A portion of this time will also be given to assisting in current studies being made by power companies on the calculator. Some work with actual central station problems will be done at the close of the first semester, since two weeks will be spent with central station engineers of the Westinghouse Electric Corporation at their East Pittsburgh plant.

The second semester will be spent in further graduate study and calculator training. At the end of this semester, another two weeks will be spent with Westinghouse central station engineers. At this time a suitable research project in the field will be discussed, and plans will be made for conducting the research investigation during the final semester of study under the fellowship.

The last semester, largely devoted to research investigation, will include continued experience on the network calculator, a graduate course of study and preparation of a thesis covering the research investigation.

Satisfactory completion of the three semester course qualifies the fellowship student to become eligible for the degree of master of science in electrical engineering.

Construction Worth $21,000,000,000 Announced

H. E. FOREMAN, managing director of the Associated General Contractors of America, has estimated that construction programs announced by private enterprise and provided for by the Federal Government, now total approximately $21,000,000,000.

"Private construction programs that have been publicly announced total about $6,000,000,000 and the public programs about $15,000,000,000," he explained. "Most of these programs cover periods of from five to ten years."

Construction programs totaling about $750,000,000 have been announced by the automobile companies; $150,000,000 by chemical and paper companies; $300,000,000 by the theatrical industry and by colleges and universities; and about $260,000,000 by a miscellaneous group of productive industries. Utility companies have the largest program with a total of about $4,000,000,000 for modernization and expansion.

A New Armature Winding Diagram

(Correction)

WE COULD BLAME it on the weather because, as most of you know, this has been terrible; we could blame it on the war, that is always a good alibi these days, or we could blame it on being short handed or overworked; the very least we could do, would be to blame it on the printer—he always makes an excellent goat, but really, when we get down to brass tacks, we can blame nobody but ourselves.

What we are getting at is the fact that there were a lot of mistakes in the article on a New Armature Winding Diagram by Mr. Taylor in the June issue. Most of them were of a typographical nature, not very serious, made by the printer, but we can't blame him because we should have caught them before the issue went to press. A few of them were in the author's original manuscript and one, the one that is really serious was the fault of the engraver who made the two-color cut on page 91.

This cut, (Fig. 1 on page 91) it will be noted, consists of a colored portion and a white portion. The position of the colored portion, which represents the whole of the No. 1 Magnetic pole zone was rotated too far to the left. It should be turned or twisted clockwise so that the sharp point ends exactly at O°-A. It is reprinted here, correctly.

The other errors are as follows:

Page 90, column 3, paragraph 1, 3rd line up should read: winding by reversing the process—(not) winding by reversing and process.

Page 90, column 3, paragraph 2, 2nd line up should read: connected in parallel—visualizing at a—(not) connected in parallel-visualizing at.

Page 91, column 3, paragraph 1, 3rd line up should read: the information tabulated in Fig. 1 and 1a are shown in Table II.

Page 92, Table IV, column 2, 3rd line down should read: per pole—(not per hole).

Page 93, column 1, paragraph 3, 3rd line down, 1st word should read: layout—(not layolt).

Page 93, column 2, paragraph 2.
$12/6 = 2$ (not $12/6 = 20$)
also
$6/4 = .666$ should read $4/6 = .666$
$8/4 = .500$ should read $4/8 = .500$
$12/4 = .383$ should read $4/12 = .333$

Page 93, column 3, question 2, should read: what—(not, whate).

And, finally, since there were five preceding parts to Mr. Taylor's series, the article in the June issue should be called, "Part VI," not Part V.

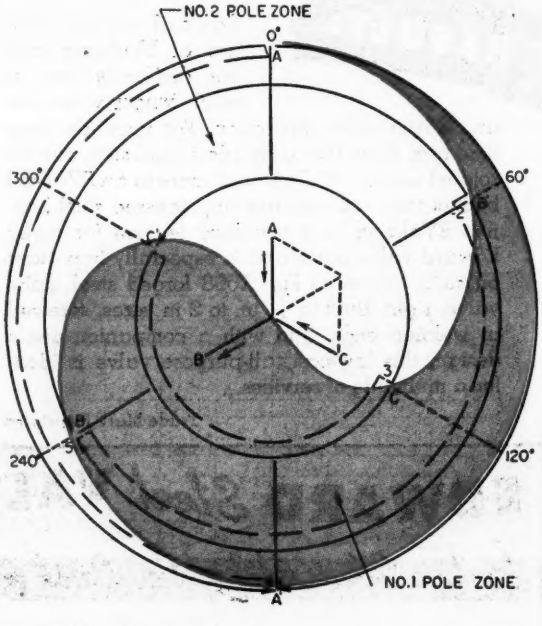
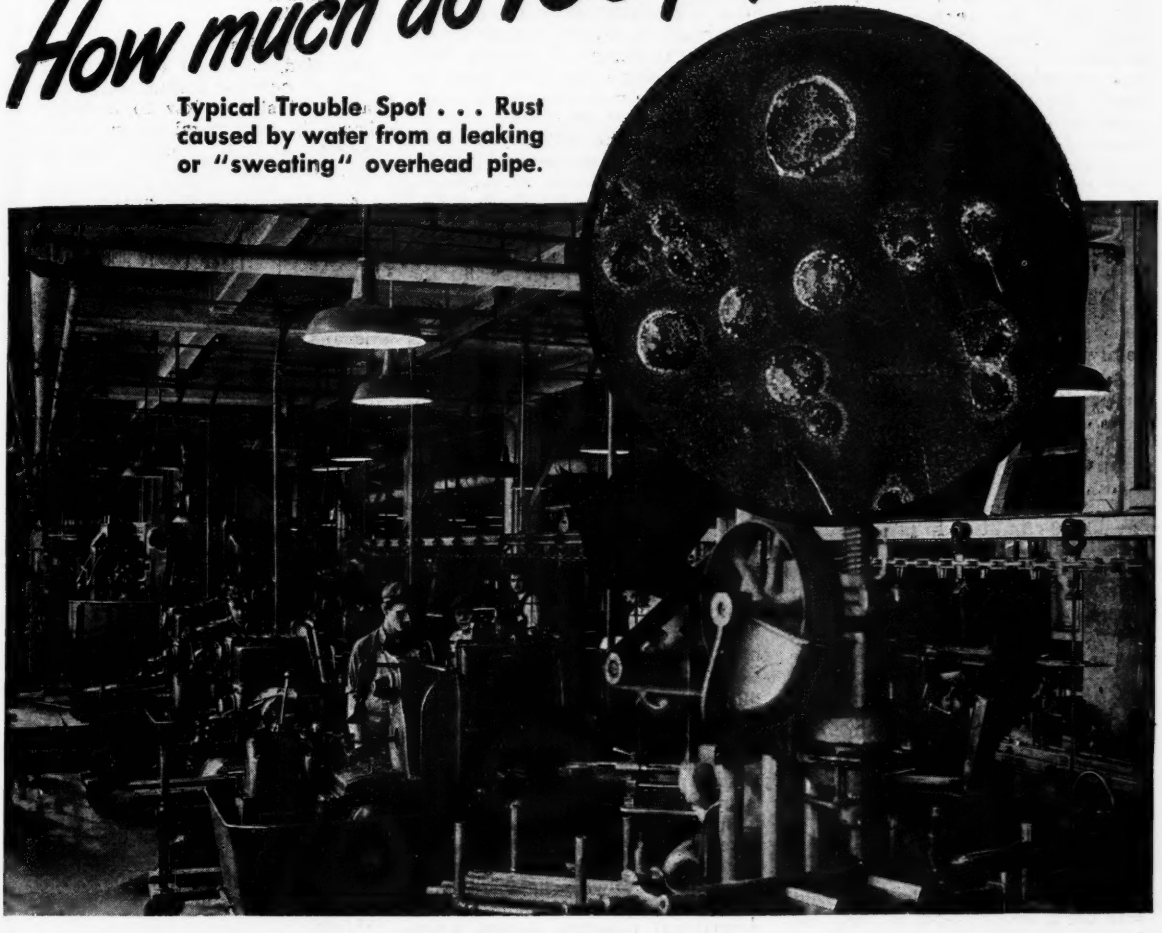


Fig. 1. Polar diagram of a 2 pole, 3 phase, 6 slot and coil full-pitch lap-winding layout

How much do YOU pay for Rust?

Typical Trouble Spot . . . Rust caused by water from a leaking or "sweating" overhead pipe.



$100,000,000—that's just a conservative estimate of the annual losses caused by rust . . . *how much is your share?*

Precautionary measures can minimize or completely eliminate rust destruction—save you money and production headaches.

Cities Service Rust Remover is an unexcelled first-step in plant-protection. This fast-acting liquid dissolves rust from iron or steel and removes tarnish from aluminum, brass, copper and other non-ferrous metals. It's simple to apply and easy to remove.

After cleaning, your Cities Service engineer will show you how to protect and preserve the cleaned metal surfaces with a special coating of one of our exclusive Anti-Corrodes.

Cities Service will be glad to study your plant operations and recommend a suitable rust-prevention program without obligation on your part.

You may avoid considerable trouble and expense. Consult a Cities Service expert today.

CITIES SERVICE OILS
ONCE-ALWAYS

MAIL THIS COUPON TODAY!

Cities Service Oil Company
Room 375, 70 Pine Street, New York 5, N. Y.
Gentlemen: I am interested in your Rust Prevention Program. Please contact me.

Name.....
Title.....
Company.....
Address.....
City.....State.....

Gas Turbine Operation

(Continued from page 79)

tion of the Houdry units requires the steady flow of regeneration air under varying pressure differentials and also changes in the system pressure differentials due to changes in operating conditions. The quantity of air delivered by the axial flow compressors discussed herein fluctuates less than 1 per cent for 20 per cent variation in discharge pressure as opposed to approximately 20 per cent or more for similar changes in pressure conditions in the case of centrifugal compressors. There has not been offered a suitable centrifugal compressor nor a prime mover to replace the gas turbine meeting the requirements of economy and efficiency necessary in connection with the regeneration of catalysts in the Houdry catalytic operation.

In this application, it is necessary to handle gas at high pressures and in large quantities utilizing combustion products resulting from the chemical reactions obtained from the catalytic cracking processes. It is obvious that a catalytic plant requiring 40,000-cfm at 45 lb pressure cannot obtain high economic efficiency if it were necessary to compress this amount of air without using resultant combustion products as the source of power for the compression of the air.

The assistance of Messrs. C. H. Thayer, Chief Engineer, Sun Oil Co., and H. E. Melton, Assistant Superintendent, Power Division, Sun Oil Co., in the preparation of this report is acknowledged and appreciated by the author.

In discussion of the paper, the author stated that there seemed to be no decrease in output of these units with passage of time, indicating little wear. Starting time, he said, was not a major factor in this case, because the process was shut down for regular maintenance only twice a year and unforeseen outages had been few. For the same reason, the combustion chamber preceding the turbine is in operation only 8 to 10 min. during starting up, hence no fouling of this chamber has been observed.

Value of the electric power obtained from these gas turbines, the author stated, is high. The power is cheaper than available purchased power.

In the discussion, Mr. Mann of Socony Vacuum Oil Co. stated that the experience of his company with gas turbines in similar application had very closely paralleled that of Sun Oil Co. Some bearing trouble was experienced and similarly remedied by installation of Kingsbury bearings. To prevent catalyst carryover, precipitators were used. On the whole, he said there had been very little trouble with the Socony-Vacuum gas turbine units.

Centrifugal Pump Control

(Continued from page 88)

prove to be the most practical one. An excellent example of this statement is one solution of the problem of paralleling several turbine driven centrifugal pumps. It would seem that if a single regulator were installed in the main steam line ahead of the branching-off to each turbine, as in Fig. 9 the difficulty of close duplication between several regulators (the more usual arrangement, as in Fig. 8) would be eliminated.

However, an isolating valve must be installed in each individual turbine steam line so as to permit the operation of any one turbine independently of the others. In addition, several regulators, each serving its own turbine, are actually more foolproof than a single main regulator. In the event of failure of one regulator, there would still remain a sufficient number of turbines able to operate in an emergency. Thus, to obtain a certain degree of reliability, it would be necessary to install a bypass around the single regulator, a spare regulator being installed in this by-pass. Now, both the main and the spare regulators must be equipped with their own isolating valves and the solution, while technically satisfactory, fails of practicability. In other words, the hookup has too many valves.

Control Supplements, Not Supplants

It should also be well remembered that in most cases automatic control is directed at supplementing, not supplanting, proper instrumentation and careful observation by the operators. An indicating or recording instrument should always be installed in the proximity of the point in the centrifugal pumping system where control action is applied. This instrument, which registers flow, level, pressure or temperature—depending upon which of these variables it is necessary to control — is especially important in the case of fully automatically operated controls, as it will indicate at a glance whether the control operates properly and can even be arranged to warn the operator of any failure in the functioning of the control.

What to Tell the Control Manufacturer

It is necessary that when selecting or ordering centrifugal pump controls, the information furnished to the control manufacturer be as complete as possible. Some of the most essential data as to the contemplated installation are listed below:

1. Service or control function. What is it desired to accomplish?

2. Nature of fluid handled. Obviously, the character of the fluid will have an effect on the selection of the type and even in some cases, of the size of the required valving. If the liquid is corrosive, indicate complete analysis. Likewise, if the viscosity of the liquid differs appreciably from that of water, indicate average or, at least, range of viscosities. Specify the temperature of the liquid and whether it is constant or variable.

3. Capacities of the flow being controlled, values of the initial and final pressures, if pressures are regulated. If steam flow to a turbine driving a centrifugal pump is to be controlled, full steam conditions must be indicated.

4. Character of the system operation, is it constantly under load or is the operation intermittent?

5. Is the control to be manual or automatic? If the latter, which elements of the control must be automatic and which can be manually operated? Is remote control indicated or can it be self-contained?

6. Required accuracy of regulation.

7. Required range of adjustment.

8. Is dead-end service involved for the regulating valve or is the flow continuous and small leakage, as in double seated valves, permissible?

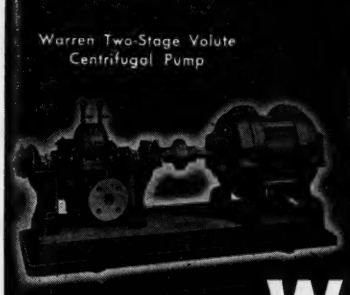
9. Should failure of control place the regulating valve into fully open or fully closed position? This question is especially important in the case of protective controls.

10. Structural details: position of valve (vertical or horizontal); type of connections for valve nozzles (if flanged, state desired facing and drilling).

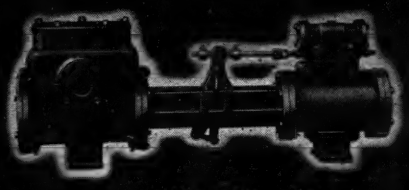
11. For all of the above, indicate the full operating range of all variable factors, such as capacities pressures and temperatures, including definite maximum and minimum values.

Obviously, there is much more to the technique of control application than can be presented within an article such as this. In most cases, however, experience is by far the best teacher when compared to the written word. And since, in the absence of a sufficient fund of experience, an engineer may have to rely on the somewhat less reliable trial and error method, this series of articles can do worse than finish with the fervent hope that the readers encounter better luck than may be expected from the operation of the law of averages.

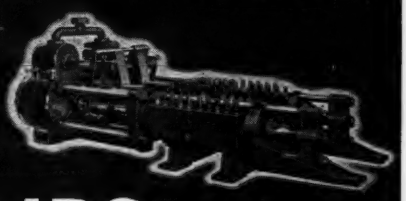
THE WORLD'S coldest thermos bottle is in a shipyard where liquid oxygen is stored at 297 deg below zero. Electric heaters convert the liquid to gas which is piped under pressure to welders, burners and other special operators and made available at hundreds of outlets. This supplants the time consuming method of carrying heavy cylinders to many points of work.



Warren Two-Stage Volute Centrifugal Pump



Warren Steam Heat Vacuum Pump



Warren Horizontal Duplex Hydraulic Pump

WARREN PUMPS

for Post-War Planning Include:

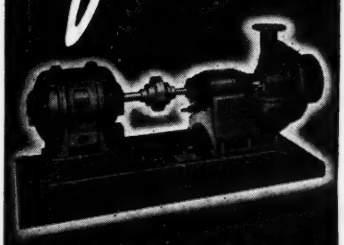
CENTRIFUGAL

Single and multi-stage
Pressure range: 0 to 850 P. S. I.
Capacities: 0 to 36,000 G. P. M.
Types: Horizontal & Vertical
Impellers: Open or enclosed
Casings: Horizontal or Vertical Split, cast iron or bronze
Bearings: Sleeve or ball-bearing

RECIPROCATING

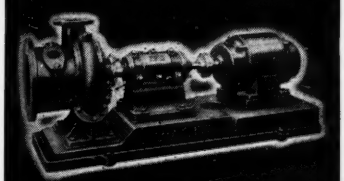
Horizontal and Vertical single piston
Horizontal and Vertical duplex piston
Single and Duplex Outside Packed Plunger
Single, Duplex and Compound Hydraulic
Steam Heat Vacuum
Automatic Pump and Receiver, etc., etc.

Send your pumping problem to us; our Engineers will recommend the right pump for the job.



Warren Type "L" Single-Stage Single-Suction Liquor Pump

Warren 14-in. Single-Stage Double Suction Pump



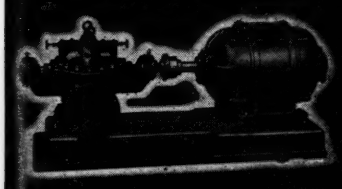
Warren Heavy Liquid Centrifugal Pump

Warren Two-Stage Volute Centrifugal Pump

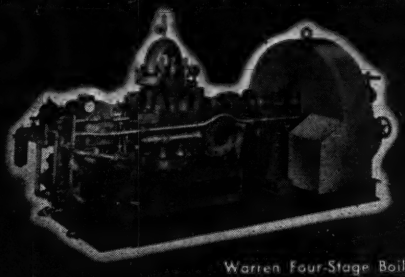
ARMY E NAVY

WARREN STEAM PUMP COMPANY, INC.

WARREN, MASSACHUSETTS



Warren Single-Stage High Speed Centrifugal Pump



Warren Four-Stage Boiler Feed Pump

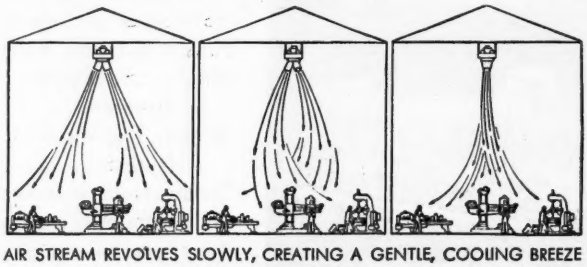
Warren Horizontal "Realwear" Duplex Piston Pump

Cooling with Heaters!

WING REVOLVING UNIT HEATERS
(WITH STEAM TURNED OFF)

Keep Workers Cool, Comfortable and Invigorated . . .

THE same virtues that make Wing Revolving Unit Heaters the ideal means of heating a plant or building are responsible for their unparalleled success in summer cooling. With heating sections turned off and only the fans operating, the discharge outlets revolve slowly, just as they do for the distribution of heated air, projecting a cooling stream of air to the working level, sweeping slowly around and under machinery and other obstacles, relieving the oppressive, stagnant atmosphere, bringing renewed vigor to the workers.



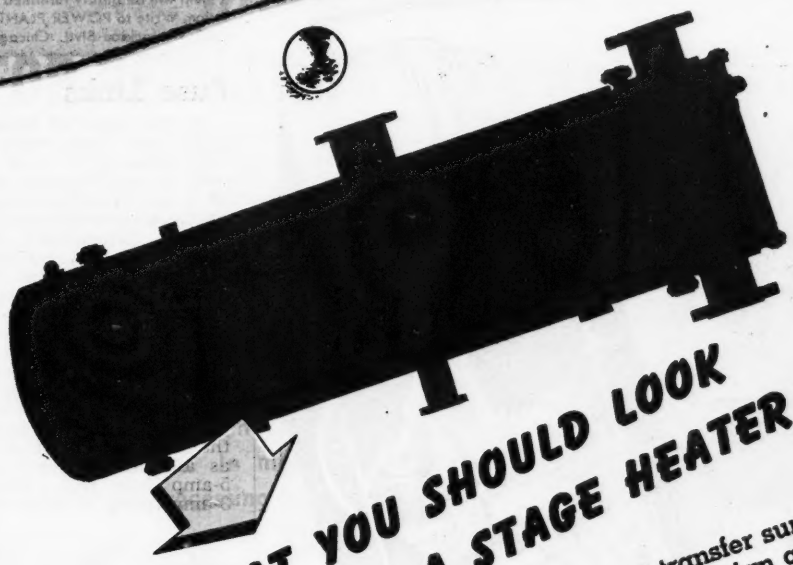
AIR STREAM REVOLVES SLOWLY, CREATING A GENTLE, COOLING BREEZE

WHY THE REVOLVING DISCHARGE IS SUPERIOR • FOR BOTH HEATING AND COOLING •

The exclusive Wing revolving discharge secures its uniform, even distribution because it moves slowly through the full 360° of a circle, thereby spreading the streams of air to all sides and corners of room or building, circulating over, under and around obstructions and creating a gentle, pleasant movement of the air around the workers. In winter, this movement of the heated air warms pleasantly, while avoiding hot blasts. In summer, it cools by keeping the air in motion, the best-known method of cooling.

L. J. Wing Mfg. Co. 64 Seventh Ave., New York 11, N. Y.

Wing REVOLVING UNIT HEATERS



WHAT YOU SHOULD LOOK FOR IN A STAGE HEATER

ONE OF A SERIES OF ADVERTISEMENTS DESCRIBING THE MANY TYPES OF G-R HEAT TRANSFER APPARATUS

In addition to the proper amount of heat transfer surface, a stage heater must have several features of design and construction to assure and maintain satisfactory operation and service.

Some of these features are:

Positive prevention of leakage at water heads.
Free expansion and contraction of tubes.
Ample support of tubes to prevent sagging and vibration.
Effective baffling of steam and air.
Utmost simplicity combined with sturdiness.
Convenience of access and ease of maintaining tightness of gasketed joints.

All these, and other advantageous features . . . many of them exclusive . . . are provided in the various types of G-R Stage Heaters for high, moderate and low pressures. Our Bulletin 277 describes these units in detail and explains how G-R Stage Heaters assure exceptional heating effectiveness, trouble-free service, and economical maintenance. Your copy of this informative bulletin will be sent on request.

G-R BUILDS ALL THESE UNITS FOR HEAT TRANSFER SERVICE . . .

- Evaporators
- Stage Heaters
- Gas Coolers
- Drain Coolers
- Aftercoolers
- Air Preheaters
- Fuel Oil Heaters
- Jacket Water Coolers
- Process Heat Exchangers
- Transformer Oil Coolers
- Generator Air Coolers
- Lubricating Oil Coolers
- Storage Tank Oil Heaters

THE GRISCOM-RUSSELL CO.
285 Madison Ave., New York 17, N. Y.

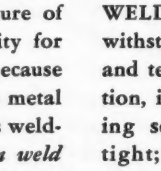
GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

"LET'S USE REX-WELD!"

. . . that's a familiar refrain among engineers and production men in every field—diesel, oil, power, machinery, steel and many others. It's not hard to understand why REX-WELD has achieved such high standing with users of flexible metal hose!

National Supply Company Diesel with RW-89 All-Steel Diesel Exhaust Unit.

For industrial men know that REX-WELD Flexible Metal Hose provides an added measure of strength and dependability for heavy-duty jobs. That's because it is fabricated from strip metal by a precision autogenous welding process that makes *a weld stronger than the tube.* In addition, C.M.H.'s advanced "50-50" principle of construction produces deep, uniform corrugations with less working of the tube walls. The result—flexible metal hose with greater inherent strength . . . extra flexibility . . . longer service life!



RW-89 Diesel Exhaust Unit.

They know, too, that REX-WELD has the ruggedness to withstand extremes of pressure and temperature. That, in addition, it is leakproof in conveying searching fluids; pressure-tight; and able to withstand prolonged vibration, flexing and bending.

Small wonder, then, that when the job calls for flexible metal hose—industrial men say, "Let's use REX-WELD!"

Consult C.M.H. about how REX-WELD can meet *your* requirements.

Flexible Metal Hose for Every Industrial Use

ARMY E NAVY

CHICAGO METAL HOSE CORPORATION

MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

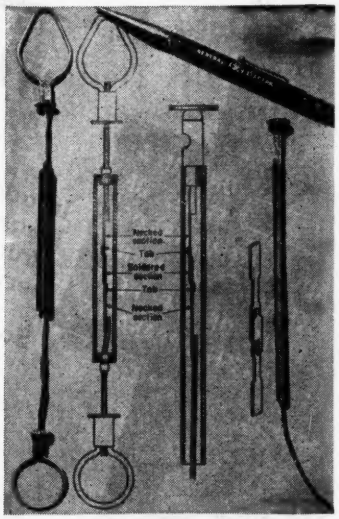
NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. Write to POWER PLANT ENGINEERING 53 W. Jackson Blvd., Chicago 4, Ill.

Fuse Links

A NEW LINE of Hi-surge double-duty fuse links, with low-current "N" rating of 1, 2, or 3 amp, each with a surge-blowing characteristic of a 5-amp conventional fuse link, has been announced by General Electric Co., Schenectady, N. Y. Available in both universal cable-type and flip-open type designs, they are mechanically and electrically interchangeable with conventional fuse links of the same type now in service.

At transformer installations, now using 5-amp minimum fusing, the new Hi-surge fuse links permit improved overcurrent protection with the same freedom from fuse blowing as afforded by the conventional 5-amp fuse link. When 1, 2, or 3-amp fusing is used, the new links

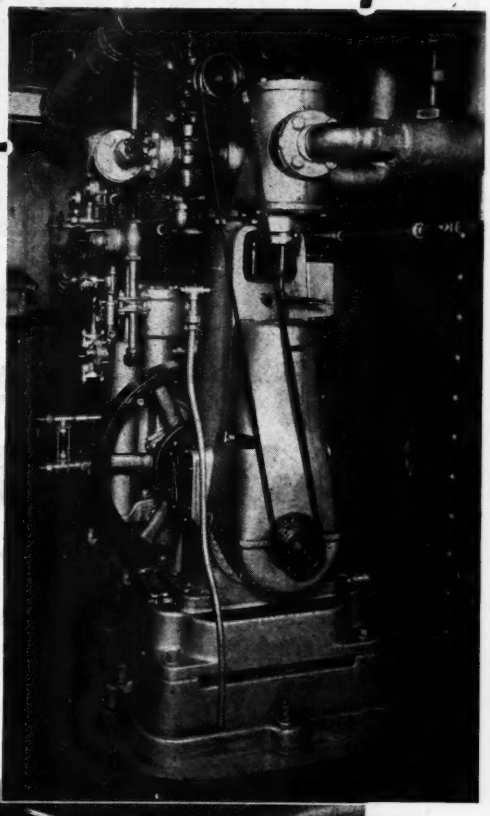


permit reduced blowing by lightning or other surge currents with the same overcurrent protection as afforded by the conventional fuse links.

The fusible element consists of two identical punchings of a low-melting-point alloy. The two punchings, each consisting of a reduced fusible section and a wider portion, are mechanically interlocked and joined with a solder of the desired melting temperature. At low 60-cycle short-circuit currents, heat generated in the reduced sections of the fusible element is conducted into the wide portion until the solder melts, permitting the two sections to be pulled apart. At higher, 60-cycle, short-circuit or surge currents, the reduced section melts and severs the link before the heat conducted into the wider section can melt the solder.

The locking construction of the two punchings prevent the ends of the soldered joint from peeling apart under tension, yet permit the punch-

One More Place to Look
FOR REDUCTION IN POWER COSTS



IMPROVED DESIGNS of stokers and boilers are helping plants offset rising fuel and labor costs in steam generation, but that is not the limit to which economies can be carried. In most plants where steam is generated for processing purposes another important saving can be made by utilizing By-Product Power in the steam.

In many cases, steam passes through a pressure reducer before passing to its ultimate destination. To obtain By-Product Power pass the steam through a Troy-Engberg Steam Engine, instead of the pressure reducer. The power thus converted can be used to drive generators, stokers, compressors, ventilating systems and many other types of equipment. Power savings thus effected will quickly pay for your Troy-Engberg Engine—in some instances in as little as six months.

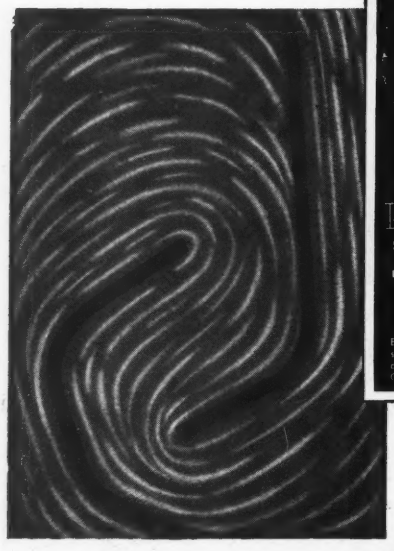
Ask for Troy's recommendations in your own set-up. There is no obligation, of course.

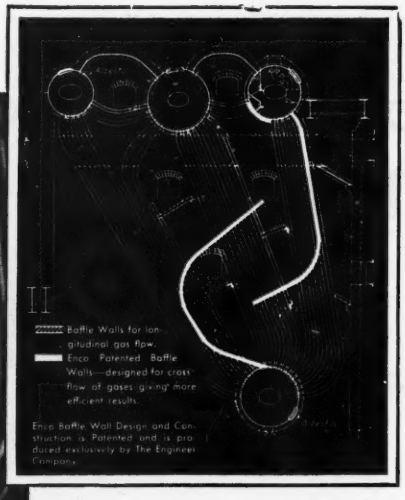
Send for Bulletin 306

TROY ENGINE & MACHINE CO.

Established 1870

878 Railroad Avenue **Troy, Pennsylvania**




Baffle Walls for longitudinal gas flow
Enco Patented Baffle Walls—designed for cross flow of gases giving more efficient results
Enco Baffle Wall Design and Construction is Patented and is produced exclusively by The Engineer Company

CORRECT BAFFLES SAVE FUEL!

Too often it is found that the Baffle Walls in existing boilers were originally located with a view to low cost of installation rather than in the most effective position for efficient results.

Enco Baffles increase steam production, improve boiler performance and save fuel, by streamlining the cross flow of gases over the boiler tubes through passes that are correctly proportioned to maintain the proper velocity and heat transfer, utilizing every square foot of heating surface.

Bottle necks and dead gas pockets are eliminated and draft losses reduced. The rapid flow of gases across the heating surface tends to clean the tubes, cutting down use of soot blowers — a further saving in steam.

It may be we can design and build a better baffle wall for *your* water tube boiler. Our experience of 25 years in this highly specialized branch of engineering is available to you.

Send us your boiler print and ask for a new baffle design. No obligation to you.

ENCO STREAMLINE BAFFLES
Produced exclusively by The Engineer Company

FREE BOILER BAFFLES

● *A bulletin on boiler baffles gives valuable information which every engineer should have. Ask for bulletin BW 44. It's free.*

THE ENGINEER COMPANY
75 WEST STREET • NEW YORK 6, N. Y.

Enco Streamline Baffles
PRODUCED EXCLUSIVELY BY THE ENGINEER COMPANY

ings to separate freely after the solder melts. The length of the restricted sections is held within the limits of ±0.005 in. in manufacture, and a definite amount of solder is applied in joining the punchings, so that the time-current characteristics are accurately controlled for both low-current and surge blowing.

Diaphragm Relief Valve

TWO YEARS AGO a relief valve was perfected by the engineers of the Farris Engineering Co., 345 Commercial Ave., Palisades Park, N. J., for use aboard naval and merchant marine vessels which is now being used in refineries, chemical, power and industrial plants.

This Farris Relief Valve, Type 1000, is of such construction that the diaphragm acts in several capacities. The diaphragm seals this valve from leakage encountered around the stem in the conventional design. It is highly acceptable for relief service where

there is fluid constantly on the downstream side. The valve will open to the full relieving capacity of 20 per cent overpressure.

This valve opens as a result of pressure on the diaphragm and, since its area is much greater than the disc, the force is multiplied many times. In closing, the diaphragm type of valve will close at the set pressure. There is no "weeping" or loss of pressure as a result of the valve bleeding down below the set point. These features make this Farris valve particularly applicable where the relief valve is to be used as a control valve for controlling the pressure at the relieving point rather than the use of a reducing valve.

This Farris valve line is being expanded to all sizes and all types of connections to meet demands.

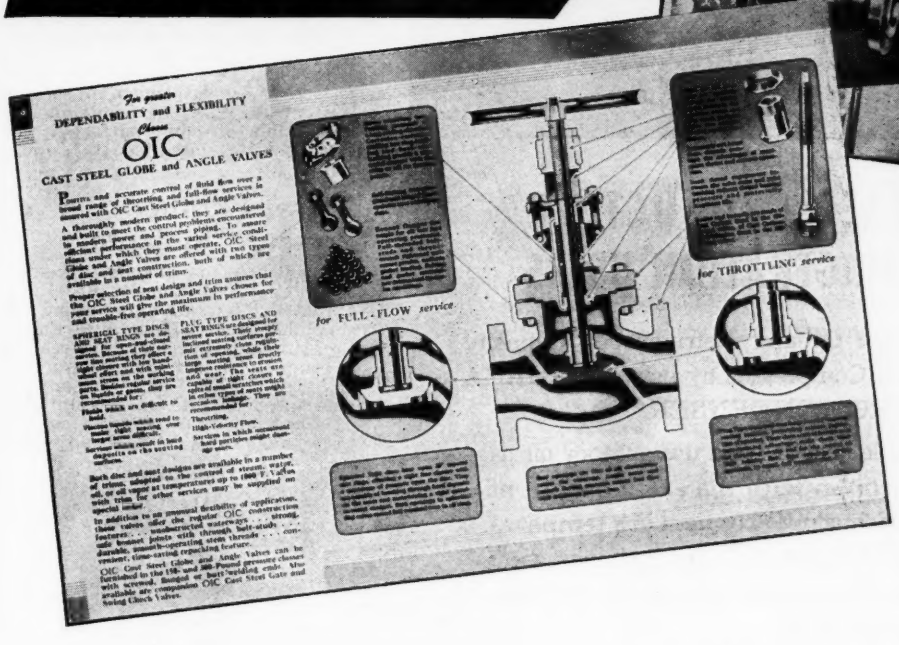
Belt Static Conductivity Test

AN EASY METHOD to determine whether any rubber V-belt, flat belt, hose or other product is static conductive has been developed by technicians of The B. F. Goodrich Co., Akron, Ohio, which was among the first to develop rubber compounds which conduct static.

The company recommends that all static conductive rubber belts be

Something New

IN CAST STEEL— GLOBE *and* ANGLE VALVES



For greater DEPENDABILITY and FLEXIBILITY Choose OIC

CAST STEEL GLOBE and ANGLE VALVES

Precise and accurate control of fluid flow over a broad range of throttling and full-flow services is assured with OIC Cast Steel Globe and Angle Valves.

A thoroughly modern product, they are designed and built to meet the control problems encountered in modern power and process piping. To ensure efficient performance in the varied service conditions under which they must operate, OIC Steel Globe and Angle Valves are offered with two types of disc and seat construction, both of which are available in a number of trims.

Proper selection of seat design and trim assures that the OIC Steel Globe and Angle Valves chosen for your service will give the maximum in performance and trouble-free operating life.

SPHERICAL TYPE DISCS AND SEAT RINGS are used where quick action is required for open-and-shut service. Because of their spherical contact with the seat rings, these discs self-align and wipe the seats clean as they close. Seating contact is thus assured, even though the seats may not be perfectly true. Similar rotating action on the part of the stem is responsible for the ease with which these valves may be manipulated by hand.

PLUG TYPE DISCS AND SEAT RINGS are designed for severe service. They employ inclined mating surfaces permitting close regulation of throttling, while the large seating area provides long resistance to erosion and wear. The seats are capable of tight closure in spite of small irregularities which in other types of valves might result in serious leakage. They are recommended for:

Throttling.

High-Velocity Flow.

Services in which occasional hard particles might damage seats.

Plants which are difficult to keep:

Vacuum systems which tend to make tight seating more difficult.

Services which result in heat interchange which makes adjustments on this account necessary.

Both disc and seat designs are available in a number of trims, adapted to the control of steam, water, oil, or oil vapor at temperatures up to 1000 F. Valves with trim for other services may be supplied on special order.

In addition to an unusual flexibility of applications, these valves offer the regular OIC construction features . . . unobstructed waterways . . . strong, safe bonnet joints with through bolt-studs . . . durable, smooth-operating repacking feature.

OIC Cast Steel Globe and Angle Valves can be furnished in the 150- and 300-Pound pressure classes with screwed, flanged or butt-welding ends. Also available are companion OIC Cast Steel Gate and Swing Check Valves.

for FULL-FLOW service

for THROTTLING service

OIC

IT WILL pay you to look into the complete line of OIC Cast Steel Valves . . . for they *are* different.

You will find a RIGHT OIC Valve for every application with the right combination of trims to give you the best performance.

Take, for example, the OIC Cast Steel Globe and Angle Valves that assure you greater dependability and greater flexibility . . . positive and accurate flow control . . . maximum performance . . . longer trouble-free operating life.

These great OIC Valves are completely described in our new brochure No. 357.

Why not send today for this brochure and get the inside story of the superior service these valves will render?

Mail This COUPON

O. I. C.
125 Ejector St.
Wadsworth, Ohio

Send me copies new OIC Brochure No. 357 on OIC Cast Steel Globe and Angle Valves . . . also name of OIC Distributor nearest to me.

Name .....

Company .....

Address .....

City..... State....

THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO
Quality Leaders in Valve Manufacture Since 1883

PATENTED

INCREASED PRODUCTION FOR REFRIGERATION USERS

● You Can Obtain Greater Refrigeration Capacity from your Present Compressor by using NIAGARA DUO-PASS AERO CONDENSER.

This is possible because you use outdoor air as the cooling medium with the extra benefit of evaporative condensing! Condensing temperatures are lowered; condenser capacity is increased; head pressures are reduced—additional compressor capacity is the result.

Only the patented NIAGARA Duo-Pass makes this gain permanent because no other evaporative condenser lowers condensing temperatures to the point where deposits do not accumulate on condenser tubes. This does away with loss of time for cleaning and assures always full capacity.

Write for Bulletins 91 and 93.

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

DEPT. PP-95 6 E. 45th St. NEW YORK 17, N.Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

tested for conductivity at regular intervals of at least once monthly.

A simple assembly, using a five or six foot length of lamp cord with standard rubber socket plug, a two-watt Neon bulb, two ordinary clamps or metal prongs and two insulated handles can be readily constructed for the tests. One of the wires of the cord is cut, the Neon bulb inserted in a standard base, the insulated handles installed near the end of each wire and the prongs or clamps attached to the wires.

To make the test, part of the belt or other rubber product is moistened with water, leaving a dry section 8 to 12 in. long between the moistened surfaces, the testing assembly is plugged into any 110 v alternating current line, and the clamps or prongs applied to the moistened surfaces, with the dry in the middle.

If the bulb glows, the rubber product is a static conductor.

The belt or other article under test must be suspended in the air between the clamping points, or rest on a table or other surface which has been insulated so it is non-conducting.

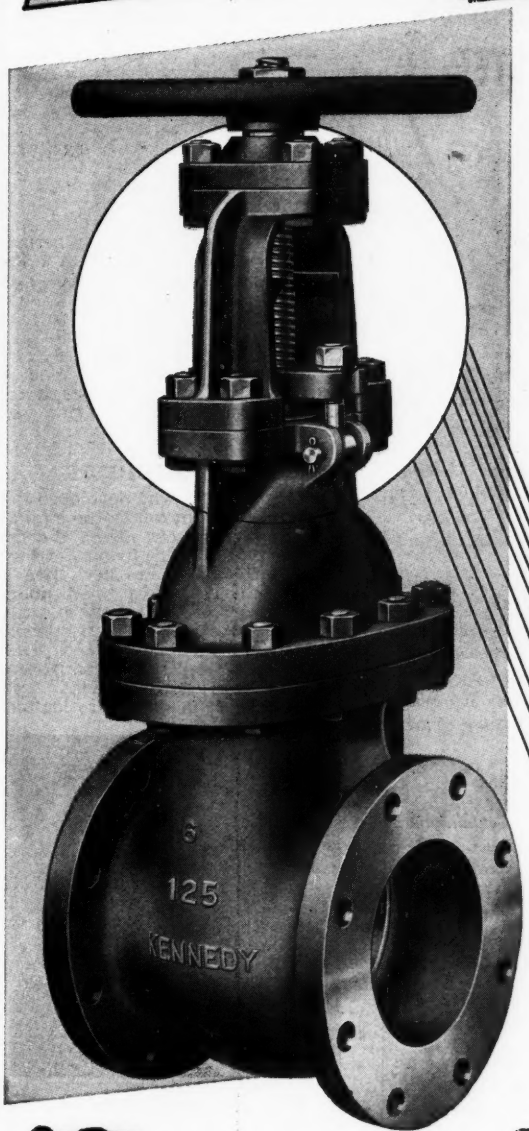
Diesel Engine Pressure Indicator

THE BACHARACH INDUSTRIAL INSTRUMENT CO., 7000 Bennett St., Pittsburgh 8, Pa., is now producing the simplified Premax Model YRF Engine Pressure Indicator for direct-reading of compression and firing pressures of any type of Diesel engine at any engine speed or rate of pressure rise. The instrument is designed so that the counter locks automatically when

the maximum pressure in the cylinder shows on the dial. This unique feature makes it practically impossible to make a mistake in reading. Another important practical feature is that only one figure appears in the window of the counter, and this figure represents the actual maximum engine pressure, in pounds per square inch.

The operation of the Model YRF Indicator is based on the principle of balancing the maximum cylinder pressure by the force of a precisely calibrated helical spring, and then measuring the deflection of the spring. The tension of the spring is increased by rotating the vulcanized handle of the

"Trifles make perfection but perfection is no trifle"



A YOKE that does far more than merely "fasten together"

Originally, the word "yoke" was applied to the contrivance that kept two oxen or other draft animals in line. But the yoke of a Kennedy outside stem and yoke valve is far from merely a contrivance for alignment. Note these features for extra strength, convenience, and ease of operation in Kennedy Standard Iron Body Wedge Gate Valves:

- One-piece yoke, wide and ribbed
- Four large bolts at yoke cap
- Extra large bolts at yoke-bonnet connection
- Bronze-to-bronze stem thread contact surfaces
- Stem contact surface in yoke cap 1½ times stem diameter
- Collar to keep stem in alignment and to prevent side thrust of stem against packing
- Provision for lubricating yoke nut bearing surfaces
- Shelves to hold gland well out of the way when repacking
- Every bolt nut accessible to a standard open-end wrench

These details are typical of the many provisions for long-continued satisfaction built into every Kennedy Valve type . . . they indicate the many advantages of standardizing on these high quality valves.

Write for the Kennedy Catalog

THE KENNEDY VALVE MFG. CO.
ELMIRA NEW YORK

One of a series of advertisements explaining how Kennedy gives careful attention to the details of valve design, construction and workmanship that provide maximum effectiveness, convenience, and length of service.

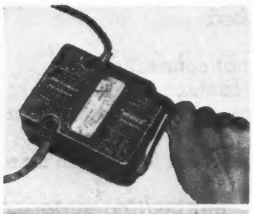
KENNEDY *valves . . . pipe fittings . . . fire hydrants*

WHICH "MEGGER" INSULATION TESTER is Best for You?

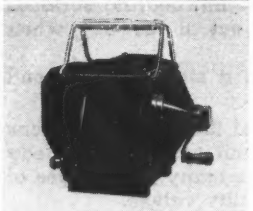
TRADE MARK REGISTERED U. S. PAT. OFF.

THE "Megger" line of instruments for testing electrical insulation is complete for ranges from a fraction of an ohm to 10,000 megohms, between which limits practically every insulation resistance measuring requirement falls. There are specific instruments for specific requirements and other types for more general use. Some users find one instrument suitable for all work, while others have use for several types.

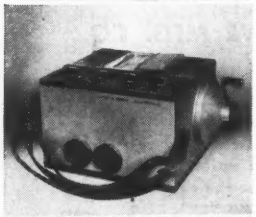
If you are uncertain which type and range of "Megger" instrument is best for your particular needs, write us, telling the type, size and rating of your equipment. We will gladly make recommedations. Write also for *Pocket Manual of "Megger" Practice*, No. 1420-PE.



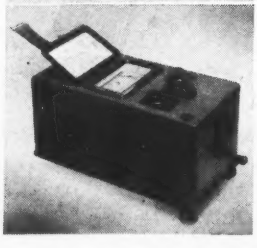
The New U. S.-Made Midget "Megger" Tester—*In many ways the most remarkable "Megger" instrument ever built. Weighs only 3 lbs—will fit an overcoat pocket or tool kit. Reads up to 50 megohms. Generates 500 volts and is always ready for use anywhere because of the hand crank. Bulletin 1785-PE.*



The U. S.-Made "Megger" Insulation Tester—*Contains the usual "Megger" direct-reading true ohmmeter, of the permanent magnet moving coil type, mounted with a d-c hand generator in a plastic molded case. Ranges up to 2000 megohms, with hand generators up to 1000 volts. Widely used in hard service. Variable-pressure ("Meg") and constant-pressure ("Super-Meg") types. Bulletin 1735-PE.*



The "Bridge-Meg" Resistance Tester—*This instrument is a combined "Megger" Insulation Tester and a four-dial, multi-ratio Wheatstone Bridge. Will measure any ohmic resistance from .01 ohm up to 100 or 200 megohms; hand generators rated up to 1000 volts. A complete and compact unit that is ideal for power companies and industrial plants. Catalog 1685-PE.*



High-Range "Megger" Testing Set—*The original heavy-duty type "Megger" Testing Instrument. Made in all ratings up to 10,000 megohms and 2500 volts. A combination high-potential testing and insulation resistance measuring set. Hand- and motor-driven types. Catalog 1685-PE.*

JAMES G. BIDDLE CO. • **1211-13 ARCH STREET PHILADELPHIA 7, PA.**

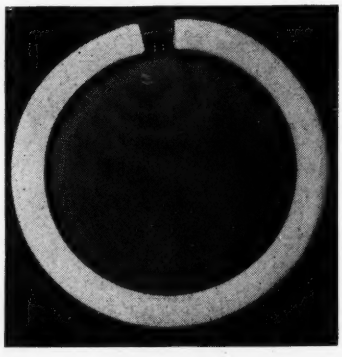
instrument clockwise, and decreased by turning it counter-clockwise. Handle rotation is synchronized with the counter. In taking a reading, the handle is turned clockwise until the counter is set slightly in excess of expected maximum cylinder pressure. Then, by rotating the handle counter-clockwise the spring pressure is reduced until the maximum cylinder pressure just offsets the spring pressure. At this instant the latch mechanism of the instrument locks the handle firmly in position, giving signal to read the counter.

Successive pressure readings may be taken rapidly with the YRF Indicator, since no venting is required between readings. According to its manufacturer, the precise factory calibration of the instrument is permanent even if it is exposed to overpressure, shock, or exceptionally severe usage.

The YRF Indicator may be used to indicate cylinder pressure up to 1700 psi. No adjustments or settings of any kind are required in the field to compensate for instrument characteristics, purpose of test, or engine conditions.

Bases for Circlines

LAMP ENGINEERS who developed the "circle of light" known as the circline fluorescent tube now report the development of a four-pin plastic base (at top of lamp). The new base is shown on the 12-in. ring, the medium-sized member of the family of three circlines which the Westinghouse Lamp Div., Bloomfield, N. J., will offer as soon as wartime manufacturing conditions permit. This base, about one inch in diameter, contains

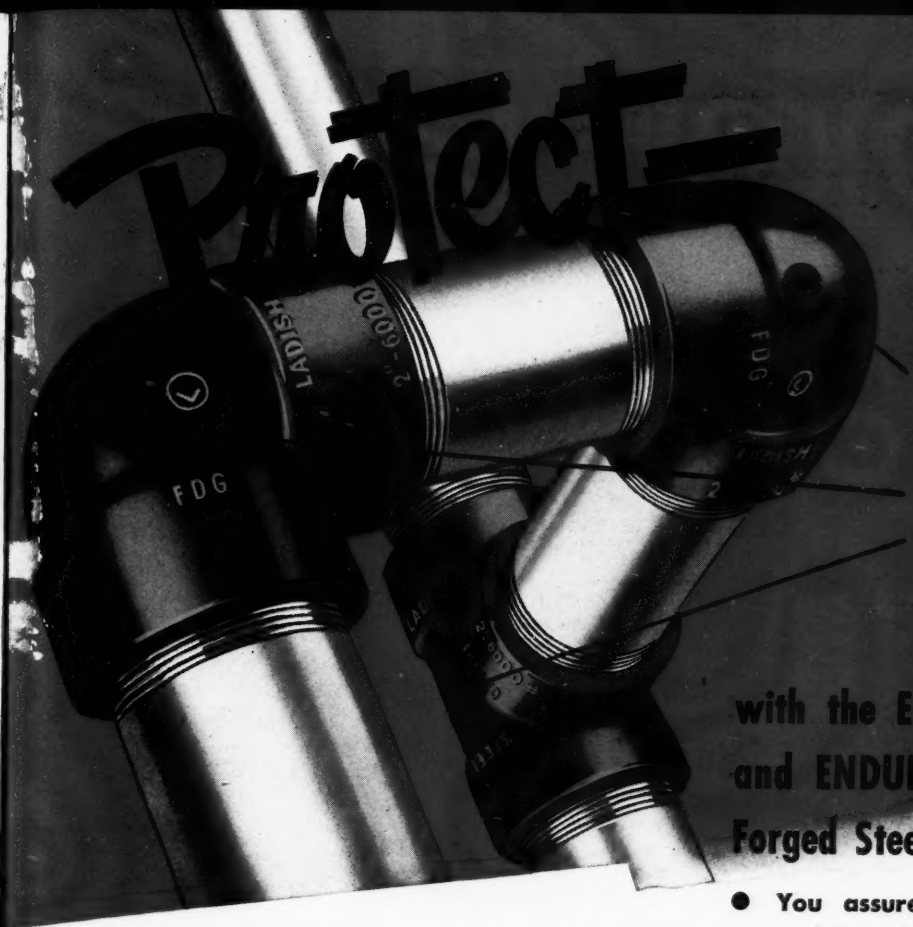


two pins from each of the two connecting ends of the lamp. For convenience in installation, particularly when nesting with the 16-in. and 8½-in. circline, the pins are mounted at a 45 deg angle to the plane of the circle.

Chlorine Comparators

THE RESEARCH DEPARTMENT of the LaMotte Chemical Products Co., Towson, Baltimore, Md., has completed a survey of the improved application of chlorine in the form of free chlorine, hypochlorites and chloramines as sterilizing agents in the treatment of water for municipal supply, for sewage and a host of industrial uses.

As a result of these studies a complete new line of LaMotte Chlorine Control Units has been made available paralleling the recent advances in the more effective chlorination pro-



These Points of Greatest Stress...

with the EXTRA STRENGTH and ENDURANCE of Ladish Forged Steel Fittings

● You assure long, trouble-free operation and protect piping systems against costly breakdowns when you install Ladish forged steel fittings. They provide the added strength to withstand mechanical strains and hydraulic shock pressures without failure.

As your assurance of proper physical properties for greatest safety and dependability, Ladish forged steel fittings are stamped with the authentic symbol of Controlled Quality identification...the Ladish Heat Code.

REASONS FOR GREATER SAFETY

1 Forged— to withstand strains of expansion and contraction under wide temperature ranges.

2 Forged— to resist fatigue failures under the strains of vibration.

3 Forged— for maximum strength to withstand hydraulic shock pressures.

4 Forged— to eliminate possibility of concealed physical defects.

5 Forged— under metallurgical controls that assure weldability.

ARMY E NAVY

TO MARK PROGRESS

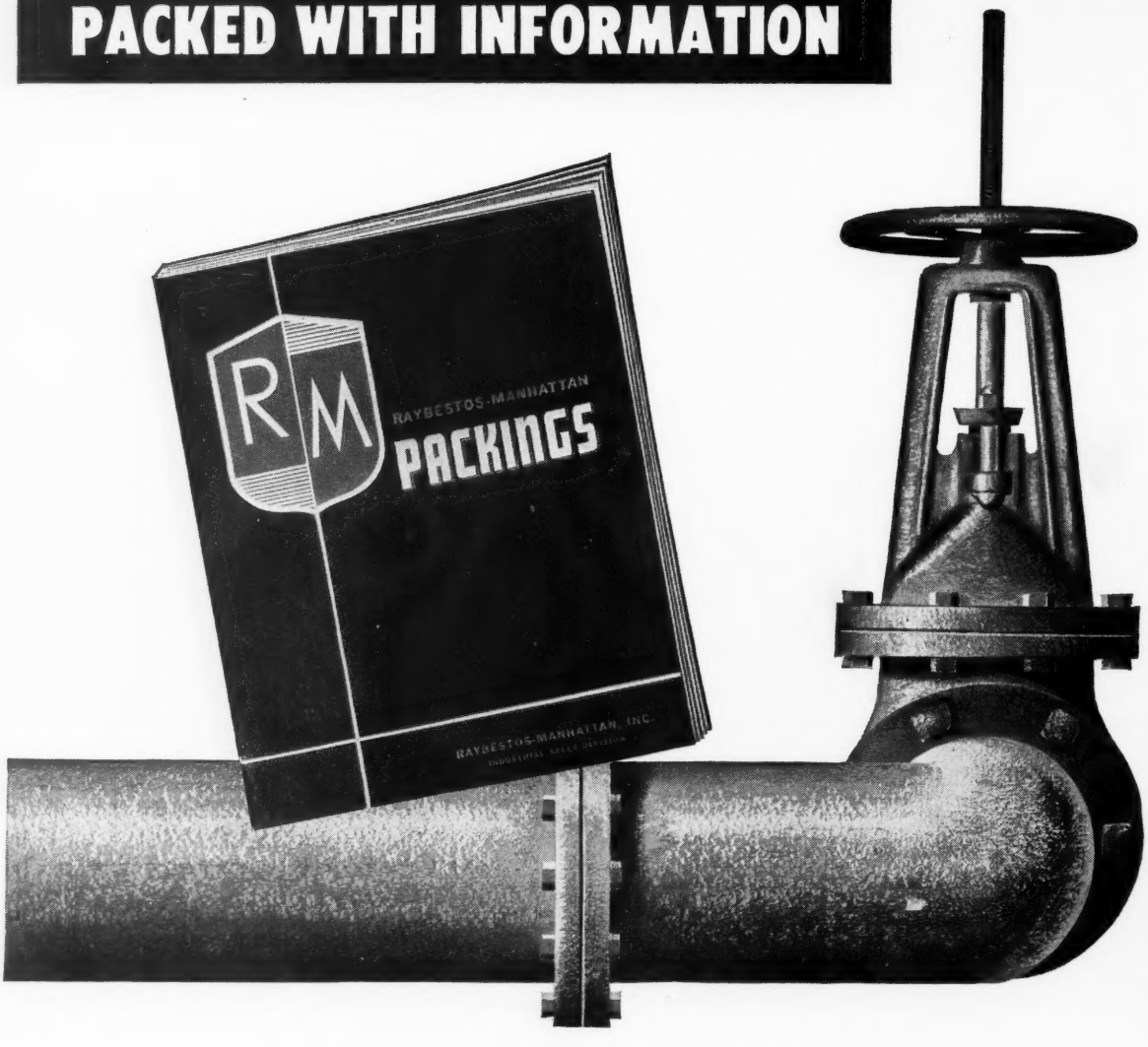
FITTINGS DIVISION

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN (MILWAUKEE SUBURB)

District Offices: NEW YORK • PITTSBURGH • CLEVELAND • ST. LOUIS • HOUSTON • LOS ANGELES

PACKED WITH INFORMATION



IF YOU USE PACKING, send for a free copy of the R/M book . . . 48 pages . . . 45 illustrations . . . chart showing proper type of packing for every industrial use . . . complete dimensions, weights, and descriptions of more than seventy types of packing . . . in hundreds of different sizes.

The R/M book is made for heavy-duty service, on strong paper with wear-resisting cover. It's indexed for each reference, and fits handily into the ordinary office-file. And it's packed with information on the greatest packing line in history.

SEND FOR YOUR FREE COPY TODAY

INDUSTRIAL SALES DIVISION

RAYBESTOS-MANHATTAN

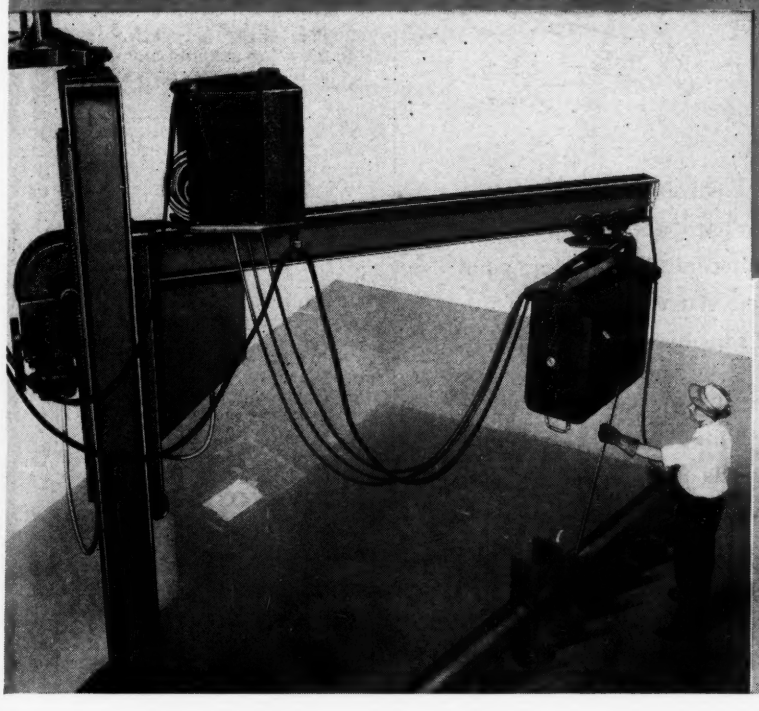
INCORPORATED

Manheim, Penna. · Bridgeport, Conn.
North Charleston, S. C. · Passaic, N. J.

It's "Packed with Satisfaction"—When You Use R/M

Danger-Proofed Piping

...BECAUSE IT'S X-RAY INSPECTED



BY specifying *X-Ray or Gamma Ray inspection,* you can be absolutely positive that fabricated piping has no hidden welding flaws.

Grinnell's scientific inspection methods and equipment make doubly sure that welded joints will safely withstand the high temperatures and pressures called for in today's power and process piping systems.

250,000 volt X-ray "eyes", so sensitive they will record the scratch of a needle on metal, search each weld through and through for the most minute flaws. Portable Gamma Ray equipment is used for inspection in the field.

When you give a prefabricated piping job to Grinnell, you can be sure of expert interpretive engineering, unexcelled laboratory research, modern fabricating facilities and positive inspection.

• • •

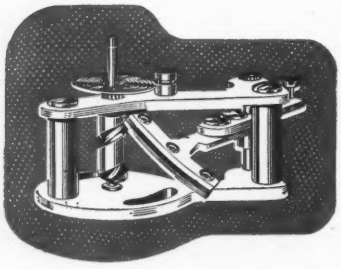
GRINNELL COMPANY, INC.
Executive Offices, Providence 1, R. I.
Branch warehouses in principal cities
Pipe Fabrication Plants:
Providence, R. I. • Atlanta, Ga. • Warren, Ohio

GRINNELL

WHENEVER PIPING IS INVOLVED

FOUNDED 1850

IT'S IN THE GROOVE!



The groove in the roller of the Helicoid movement has a helicoid surface. This surface is hard and polished. The Bakelite cam rides on this surface in continuous, rolling point contact. No metal spur gear teeth can compare with this combination in wear resistance, smoothness and accuracy.

The principle of the helicoid is as old as Archimedes. But its use to translate and multiply linear motion into rotary motion in the same plane is new in the Helicoid movement. And the Helicoid movement is the first new, major improvement in pressure gauges since the Bourdon tube was invented.

Only Certified Pressure Gauges are made with the Helicoid movement. They are guaranteed to test-gauge accuracy. Yet, they will wear longer and remain accurate longer than any other pressure gauge made. They are ideal for engines, locomotives, turbines, tractors, hydraulic presses, pumps, and compressors.

See your nearest Distributor.

Certified GAUGE AND INSTRUMENT CORP.

34-18 Northern Boulevard — Long Island City 1, New York

8-CG-2

cedures. The latest recommendations of the Committee on Control of Chlorination of the American Water Works Association have been followed, and a new series of standards has been prepared of a size interchangeable with the regular LaMotte pH color standards.

An additional new development is the ortho tolidine-arsenite test, which makes it possible to measure separately chloramine and active chlorine and, furthermore, it is possible to estimate the error that is caused by other interfering substances.

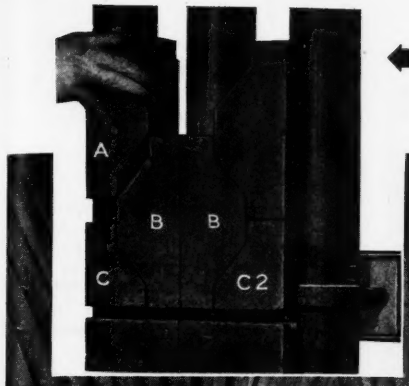
The new LaMotte chlorine testing outfits include: 1. LaMotte chlorine colorimeter—for low chlorine concentrations, 0.02 to 0.3 parts per million. Standards are prepared in special sealed Nessler Tubes, with polished tops and bottoms; 2. LaMotte chlorine block comparator (Standard Model)—for medium chlorine concentrations 0.1 to 1.0 ppm; 3. LaMotte H-C chlorine block comparator—for high chlorine concentrations, 1.0 to 10.0 ppm, and by dilution to 200 ppm and above; 4. LaMotte wide range chlorine comparator — range 0.1 to 10.0 ppm and by dilution to 200 ppm and above; 5. LaMotte roulette chlorine comparator — range 0.1 to 10.0 ppm and by dilution to 200 ppm and above; 6. Combination pH and chlorine outfits—special new combination outfits have been designed to contain any selected range of pH and chlorine standards, compactly arranged in a single case. The chlorine color standards are of a size interchangeable with the regular (15 mm) LaMotte pH color standards.

Chain-Flight Conveyor Models

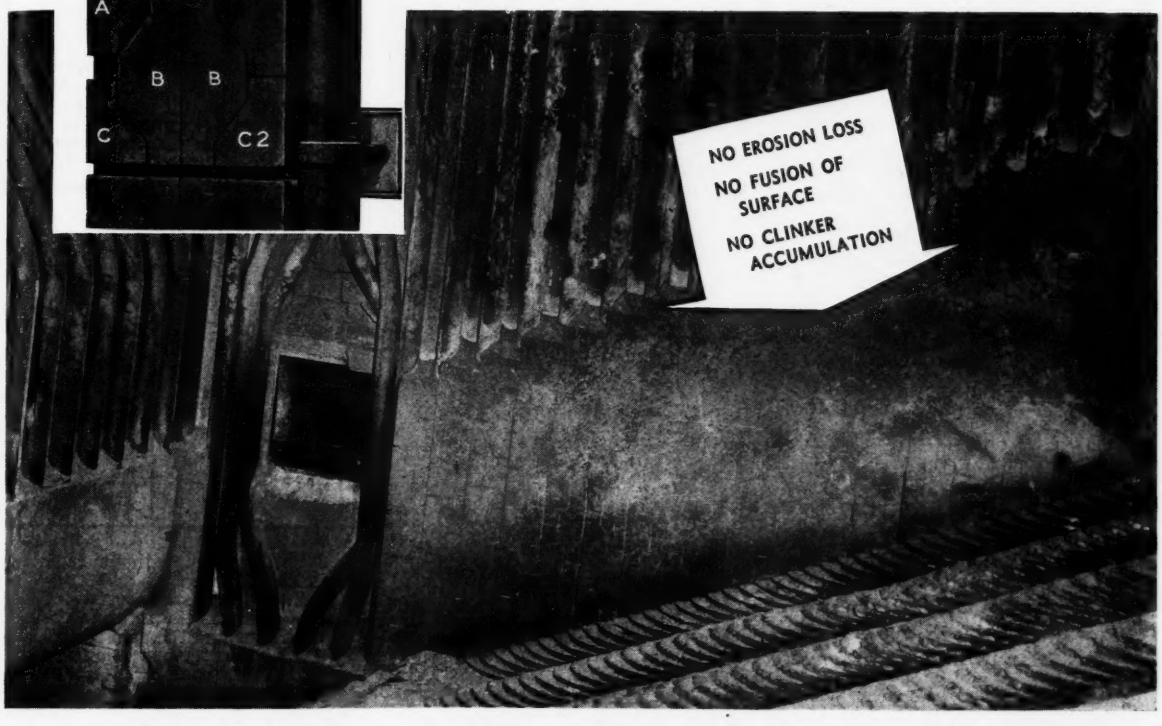
American Conveyor Co., 2435 Indiana Ave., Chicago 16, Ill., has announced the Flight-Veyor, the latest addition to its line of portable electric conveyors. Equipped with 1¾ in. chain-flights instead of a belt, it will

handle almost any type bulk material and is particularly suitable for raising bulk materials up steep pitches impractical for a belt. It is built in 4 sizes — 2 widths, 8 and 12 in.; 2 lengths, 13 and 20 ft.

It lifts up to 14 ft and is capable of delivering a steady flow of material at the rate of 160 fpm. All models are equipped with 40 ft heavy duty, rubber covered cable; drive is by means of roller sprocket chains through counter shaft; sprocket shafts mounted on self-alining ball bearings



EASY TO INSTALL—BERNITZ Water Wall Block "C" is inserted between tubes so that the cut-out at bottom fits over a "U" strap. A "B" Block is then inserted with cylindrical part against the next tube. Then "A" Blocks are dropped into place.



After 4 years Rigorous Service these BERNITZ WATER WALL BLOCKS look like New

THE above actual photo from a 100,000 lb per hr boiler at a midwestern college tells a graphic story of the durability and economy BERNITZ Nygaard Water Wall Blocks are delivering in hundreds of boiler rooms.

Installing the BERNITZ Nygaard Water Wall Covering is a simple job. The interlocking blocks are assembled and dismantled from inside the furnace without any clamps or bolts. This material is used in the clinker zone of stoker-fired furnaces, or for any other application where it is desirable to cover the water wall tubes.

Note these practical advantages of BERNITZ Water Wall Blocks over cast iron, a material frequently used as an alternate to Nygaard construction:

1. "Carbofrax"* is highly refractory and its destruction temperature is much higher than that of cast iron. Then, too, cast iron must be maintained in intimate contact with the tubes by pressure or by permanent attachment to the tubes through integral casting or welding. If this pressure contact is not maintained with cast iron, its destruction temperature is soon reached.

2. It has a high heat conductivity which makes it very adaptable for water wall covering.

3. It has the property of resisting clinker and slag accumulation.

4. It has a notably high mechanical strength.

This BERNITZ Water Wall Covering is available in virtually all tube spacings up to 12 in., and for 2 in. 2½ in., 3 in., 3¼ in. and 4 in. OD tubes.

Its flexibility of design means that a Bernitz Water Wall Covering can be added to or taken from after the original installation without disturbing the covering or the casing behind the water wall.

For further details about the construction and advantages of this and other BERNITZ refractories, write for Bulletin B-341. It points the way to better protection and economy for boiler settings.

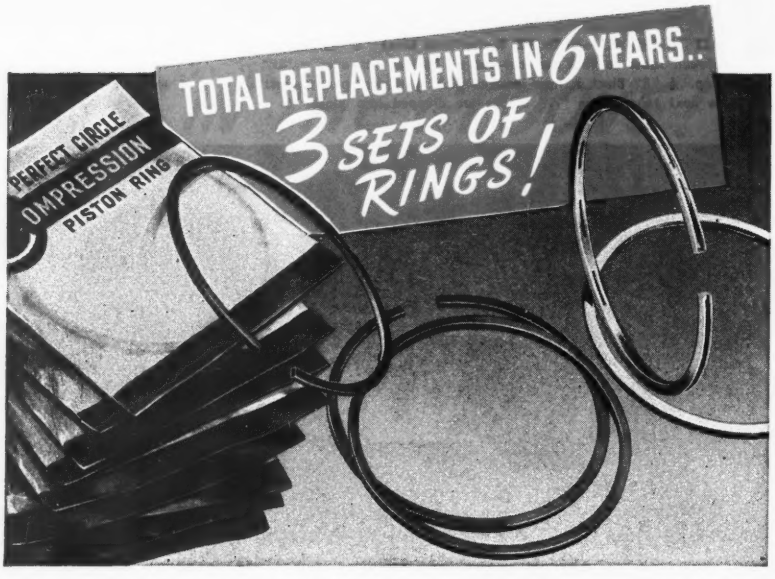
*"Carbofrax" is the registered trade mark of, and indicates manufacture by, the Carborundum Company.

BERNITZ FURNACE APPLIANCE CO. ● 89 BROAD STREET, BOSTON 10, MASS.

New York ● Philadelphia ● Detroit ● Buffalo ● Syracuse ● Atlanta ● Pittsburgh ● Cincinnati ● Chicago ● Indianapolis ● Minneapolis ● St. Louis ● Cleveland
In Canada: Williams & Wilson, Ltd., Montreal and Toronto

BERNITZ
NYGAARD WATER WALL BLOCKS

OTHER PRODUCTS INCLUDE:
BERNITZ FURNACE LININGS ● SUPER BLOCKS ● BLOCKS FOR WALLS AND ARCHES ● BERNITZ AIR-COOLED FLOORS ● BERNITZ SUPERGENERATOR LININGS FOR WATER SETS

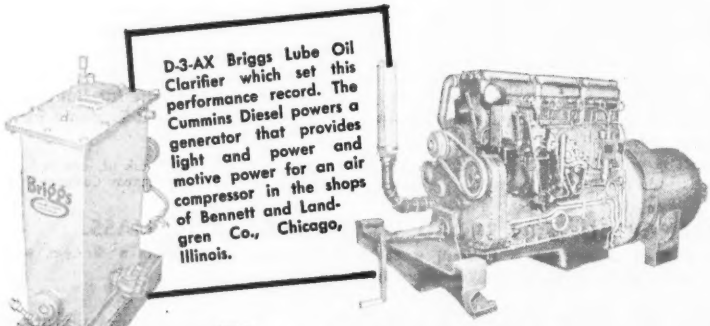


Briggs Lube Oil Clarifier on 150 HP Cummins Diesel Shows Value of Effective Lube Oil Filtration . . .

The record of savings in lube oil and engine maintenance that a Briggs Lube Oil Clarifier and a Briggs Fuel Oil Clarifier produced on this engine is typical of what really effective filtration can do . . . and will do . . . for you.

Compare facts like these with the operating record of your engine or engines . . . Operating hours, 24 hrs. per day . . . Oil change periods used to be every 250 to 300 hours, *now 3 years elapse between oil changes* . . . Piston rings only replacement parts (routine, whether needed or not) since installation of Briggs Clarifiers—6 years ago . . . Fuel pump screens have not been dirty enough to clean since Clarifiers were installed.

Look in your classified telephone directory under "Filters"—find the name of your Briggs Distributor. Get the complete, amazing story of Briggs Clarification from him or write direct for literature. No matter what size or type internal combustion engine you operate—there is a Briggs Clarifier designed to do an effective oil filtration job for it.


Briggs
D-3-AX Briggs Lube Oil Clarifier which set this performance record. The Cummins Diesel powers a generator that provides light and power and motive power for an air compressor in the shops of Bennett and Landgren Co., Chicago, Illinois.

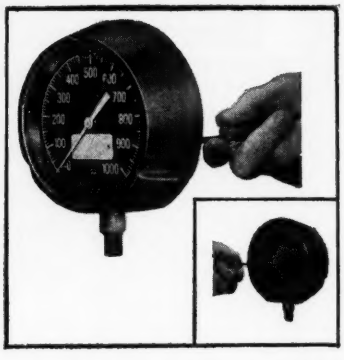
Briggs

BRIGGS CLARIFIER CO. PIONEERS IN MODERN OIL FILTRATION **General Offices, Washington 7, D.C.**

permanently sealed to retain lubricant and keep out dirt; two steel-frame, 6 in. take-ups at head pulley; heavy duty double pole switch, housed in protecting box; rigid, heavy gage steel frame, welded throughout, no bending or twisting. Heavy high carbon steel flight pan.

Pointer Adjuster

CERTIFIED GAUGE & INSTRUMENT CORP., Long Island City 1, N. Y., has announced that all of its pressure gauges are now equipped with Hairline Pointer Adjusters. With this new device, pointers can be quickly

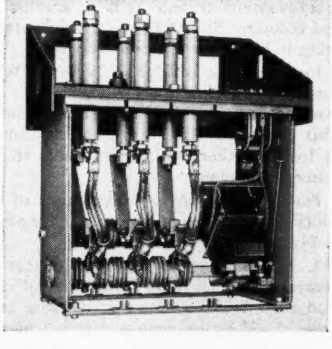


and easily reset without removing the glass or ring.

A slotted adjusting screw in back of case changes the relative position of the roller and the cam of the helicoid movement, thus changing the position of the pointer.

Motor Starting Contactor

ALLIS-CHALMERS MFG. CO., 559, Milwaukee 1, Wis., has introduced a new type "MO" oil-immersed contactor designed for heavy-duty motor start-



ing service in industrial plants. It is built in 100 and 200 amp sizes, and can be used with motors rated up to 900 hp at 2300-v.

Rigidity and alignment of parts are insured by the steel frame construction. An E-type magnet and an a-c coil with armature directly connected to the contactor shaft through a universal joint gives longer service and quieter operation.

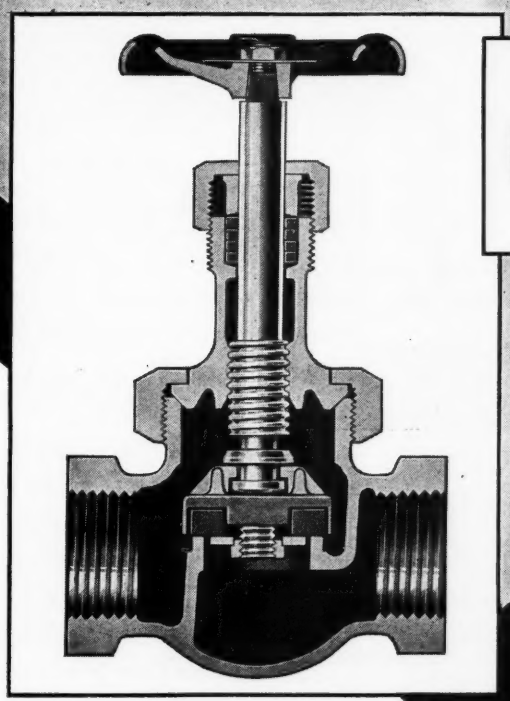
Extra heavy copper contacts give long life because the contactor mechanism causes the moving contact to roll and wipe on each operation, keeping it clean. Arcing is done on the

Originated · Developed · Improved

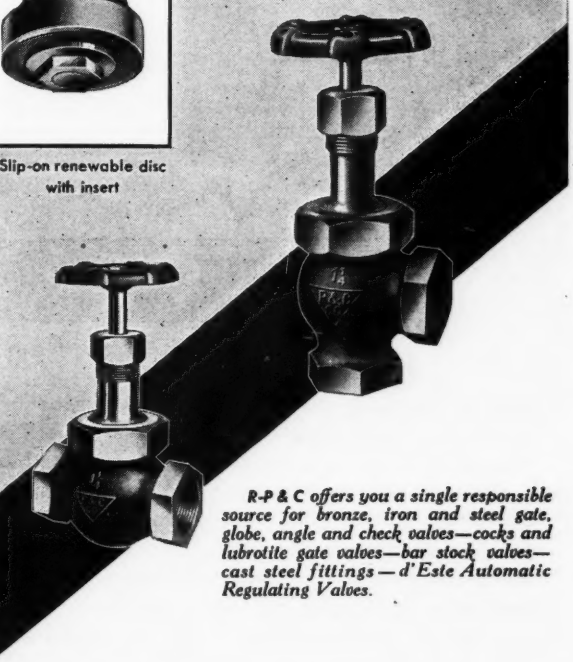
by Reading-Pratt & Cady

● Tight, sturdy, dependable, long-lasting, adaptable to many types of service—that, briefly, describes this line of bronze globe and angle valves. The slip-on renewable disc—an **R-P&C** development—can be easily and quickly replaced. Disc inserts are of asbestos composition, rubber, leather or a special metal. These insert rings are renewable separately and are of standard size—therefore, interchangeable. Union bonnet construction, with bevel between body and hub, still further simplifies the servicing of these globe and angle valves.

We suggest that you get an **R-P&C** recommendation next time you need valves.



Slip-on renewable disc with insert



R-P & C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and lubrotite gate valves—bar stock valves—cast steel fittings—d'Este Automatic Regulating Valves.

READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE AUTOMATIC REGULATING VALVES

ACCO

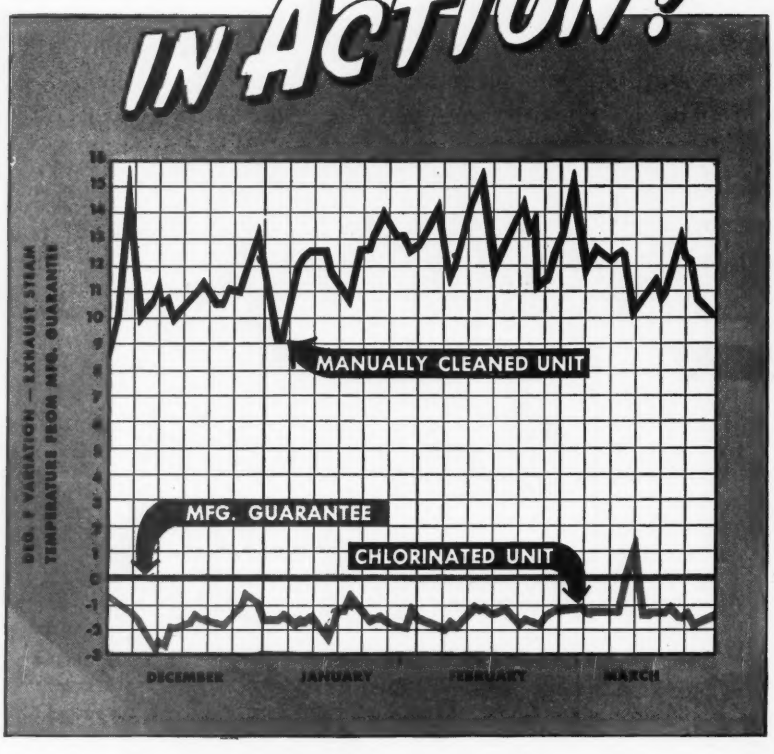
Reading, Pa. • Atlanta • Boston • Chicago • Denver • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Bridgeport, Conn.

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

HERE'S

CONDENSER CHLORINATION IN ACTION!



Charted above, is the performance, over a period of four months, of two identical condensers in a large midwestern power station. One was cleaned manually and the other kept slime free by chlorination.

Plug cleaning, *eight* times in four months, could not keep exhaust steam temperature within nine degrees of the manufacturer's guarantee. The chlorinated condenser, however, was never out of service for cleaning and kept exhaust temperature well below the guarantee with major savings in fuel and labor.

Write for further details on this installation and for data on the role of chlorination in your plant.

CD-18

WALLACE & TIERNAN PRODUCTS, INC.

Manufacturers of Chlorine and Ammonia Control Apparatus

Belleville 9, New Jersey **Represented in Principal Cities**

tips, not on current-carrying areas, for lower maintenance. Contact tips are easily replaced. Removing just one screw on either the stationary or moving contact makes the contact tip immediately available for inspection.

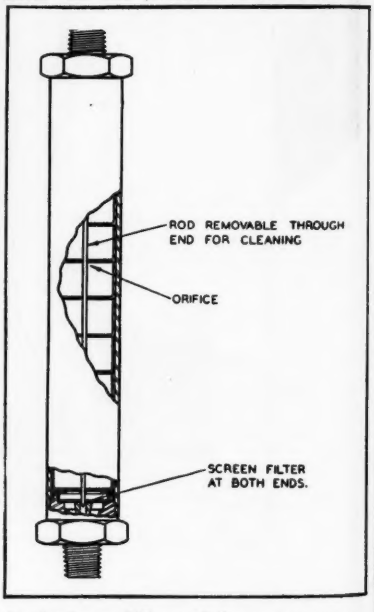
Ample insulation is provided by wide pole spacing, plus barriers, and Bakelain high dielectric bushings. Special anticreepage shaft insulation and oil immersion of the entire contactor, including coil, are provisions for greater safety.

Accessories available with the new contactor are a built-in auxiliary switch with up to four normally open or closed poles and a permanent windless type tank mechanism.

Pulsation Damping Unit

To overcome the difficulties associated with the variable orifice type and the fixed orifice type, Taylor Instrument Cos., Rochester 1, N. Y., have developed a new and different type of pulsation damping unit. It is universal in application, non-adjustable and delivers an output pressure which is essentially equal to the average flow of the pulsating input pressure.

The Taylor Pulsating Damping Unit consists of a series of alternate small capacities or volumes and orifices. As the pressure wave enters



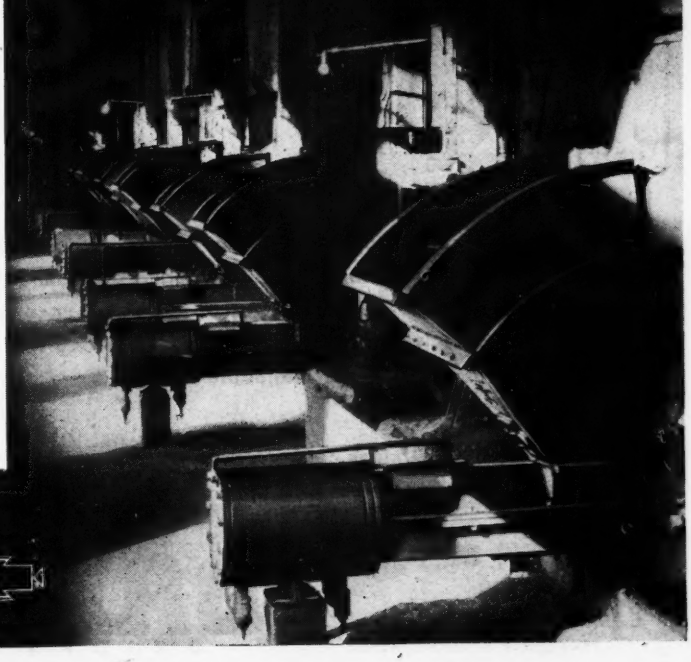
the device, a differential occurs across the first orifice which causes a flow through it, thus raising the pressure in the adjacent chamber. This in turn causes a flow through the next orifice, producing similar effects except with decreased intensity. While this "above-average" value of the pressure wave is making its way through the series of chambers, the pressure drops below the average value (since it is a pulsating one) causing a reversal of the flow process. Thus it can be said that the various capacities "breathe" with decreasing intensity as the waves pass through the damping unit until finally a point is reached where the pressure level lies just about at its average value. It is important therefore that each

CRYSTOLON BRICK *for Boiler Furnaces*

DO AWAY WITH "WATCH AND PRAY" METHODS

CRYSTOLON (silicon carbide) Brick banish "watch and pray" methods when it comes to refractory linings for boiler furnaces. It pays to install these highly refractory brick which guarantee long, trouble-free service because they are physically rugged, chemically inert and resistant to abrasion. Coal ash slag cannot penetrate the hard, dense surface of CRYSTOLON Brick and this makes clinker removal a short, easy operation.

NORTON COMPANY
Worcester 6 Massachusetts



NORTON REFRACTORIES

It Pays to Decide on Darts

BECAUSE

DARTS HAVE TWO BRONZE SEATS GROUND TO A TRUE BALL JOINT

The ball-joint grinding of Dart's two bronze seats insures *perfect* service and *much longer* wear. A leakproof connection can be made without forcing; thus a Dart can be uncoupled instantly whenever it is needed elsewhere. Body and nut are made of high-test, air-refined malleable iron, and are practically indestructible.

In the long run, Dart Unions cost the least. Ask your supplier.

●

E. M. Dart Manufacturing Co.
PROVIDENCE 5, RHODE ISLAND

DART UNIONS

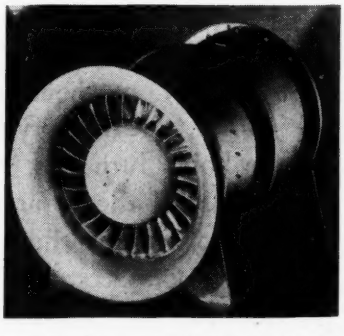
individual orifice provide the same drop for the same flow, regardless of direction.

To overcome the difficulty of plugging, fine mesh screens are provided at both the entrance and exit of the damping unit. In addition, a rod which passes axially through the series of orifices can be readily removed, thus exposing a large orifice area for simple and effective cleaning. The device is completely free of gaskets and the caps are welded to the tubes to provide leak-proof construction. The unit is subjected to a static pressure test of 3000 psi and bears a working pressure rating of 1500 psi. Adapting the unit to liquid or gas service, is made by using one of the two rods supplied, the selection of which is made at time of installation.

Axial Flow Compressors

BUFFALO TURBINE CORP., 2165 Bailey Ave., Buffalo 11, N. Y., has announced a new line of axial-flow compressors, blowers and fans. This equipment is made possible by the development of entirely new design methods developed by James G. Sawyer, vice president and chief engineer.

Due to the high capacity and small size of many of these units, it has been necessary to develop special mo-



tors, having exceptionally high capacity and small diameters. The incorporation of these motors has made possible equipment having relatively low overall weight.

Typical is the 14 in. diam blower shown, which delivers 8000 cfm and 10 in. static pressure, turning 3450 rpm. It is driven by an 8 in. diam 20 hp motor. The complete unit weighs only 130 lb. Pressure and efficiency characteristics allow economical operation over a wide range. Noise level is extremely low, as comparable pressures and flows are obtained at approximately one-half the conventional design speeds.

This new line is to include a wide range of direct driven units with air pressures from ⅜ to 100 in. of water at synchronous motor speeds. Also direct connected turbine driven units up to 100 psi and 100,000 cfm will be available.

These units have wide applications in the heating, ventilating and air conditioning fields requiring pressures up to 6 in. of water; dust removal, conveying, processing, drying and forced draft blowers requiring 10 to 100 in. of water; and coke ovens, blast furnaces and processing, requiring 3 to 100 psi.

Now UP TO 2000 hp!

STANDARD 2000-HP TRI/CLAD MOTORS NOW AVAILABLE

THEY GIVE EXTRA PROTECTION 3ways

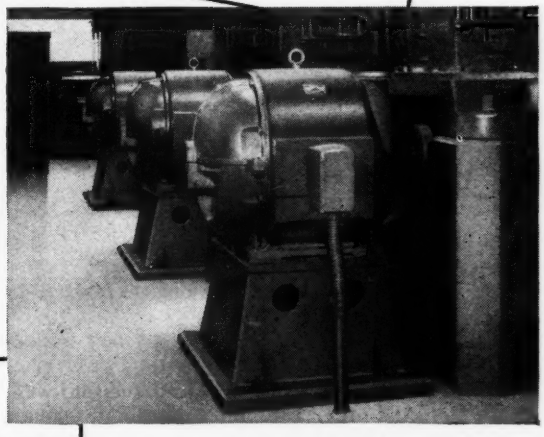
1 Extra protection from physical damage—Cast-iron construction. Upper portion completely enclosed. Streamline, cast-iron end shields. Corrosion-resisting finish.

2 Extra protection from electrical breakdown—Windings of Formex* wire, strongly bonded with oil- and moisture-resistant synthetic resins, stand up under abrasion or "heat-shock."

3 Extra protection from operating wear and tear—Sleeve or ball bearings, in dust-tight housings. Sleeve-bearing design is a further refinement of well-proved Tri-Clad bearing proportions, with cast-in "air seal" to further insure oil tightness of the housing.

The triple-protected construction that has made General Electric's Tri-Clad motor so popular in the small and intermediate sizes has now been extended to motors of 2000-hp capacity. On your *big* drives, these new Tri-Clad motors will meet severe conditions with greater assurance than ever of dependable service and long life.

The Tri-Clad motor, in its wide range of types and sizes, is industry's most popular integral-hp motor. Chances are there's a standard Tri-Clad to meet your requirements "on the nose." For information on G.E.'s complete line of Tri-Clad motors, ask for Bulletin GEA-3580. *General Electric Company, Schenectady 5, N. Y.*



Three of the new, large Tri-Clad motors, each rated 200 hp, 1200 rpm, driving coal pulverizers in a Southern steam-electric plant

*Trade-mark reg. U.S. Pat. Off.

HERE'S TODAY'S WIDER RANGE OF STANDARD SIZES	
TRI/CLAD Type K	—1 hp to 2000 hp at 1800 rpm
TRI/CLAD Type KG (High starting torque, low starting current)	—5 hp to 200 hp at 1800 rpm
TRI/CLAD Type KR (High starting torque, high slip)	—Available to 100 hp in speeds required for high-slip, flywheel drive (punch press, etc.)

Buy all the BONDS you can—*and keep all you buy*

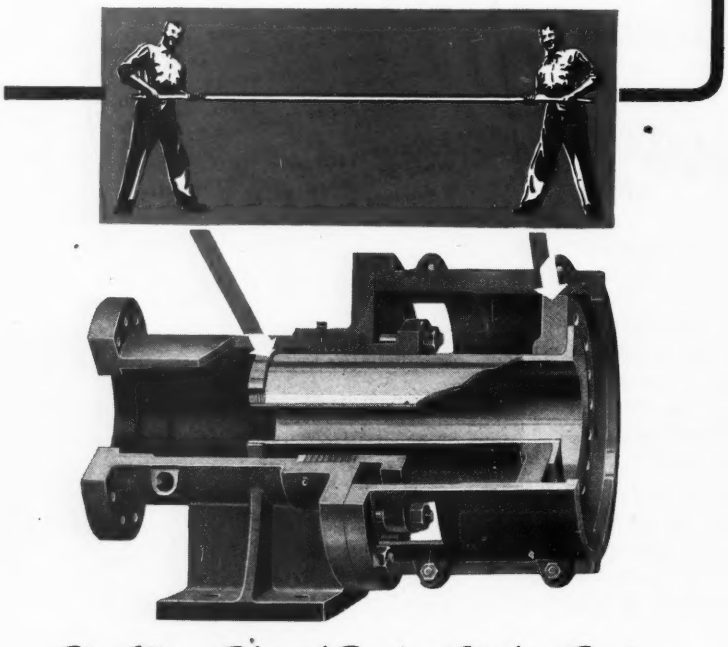
GENERAL ELECTRIC

ADSCO

INTERNALLY-EXTERNALLY GUIDED

EXPANSION JOINTS

Keep the slip in perfect alignment because they are guided at BOTH ends



Slip Moves Through Packing Without Binding

Try to hold a pole at one end and keep it level. Then have someone hold the other end, and note the difference. That's precisely why the ADSCO Internally-Externally Guided Expansion Joint stays in alignment—why the slip moves through the packing space without undue pressure or distortion.

This protection against slip scoring is the reason why the intervals between repacking are few and far between when you use ADSCO Internally-Externally Guided Expansion Joints.

Install them on high or low pressure pipe lines, hot water, fuel oil, gasoline or process—wherever the most complete form of guiding is required. Write for Bulletin No. 35-2E describing ADSCO Internally-Externally Guided Expansion Joints in sizes from ¼" up with 4" or longer traverses.

WRITE FOR YOUR COPY OF CATALOG DESCRIBING COMPLETE LINE OF ADSCO PRODUCTS

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA NEW YORK

Makers of "UP-TO-DATE" Steam Line Equipment For Over 65 Years

Obituaries

John J. Hoppes

JOHN J. HOPPES, mechanical engineer, manufacturer, inventor, civic leader, died at his home in Springfield, Ohio, on July 12, 1945, at the age of 87 years following several years of failing health. Mr. Hoppes was born on a farm in Pickaway County, Ohio, on September 4, 1857, the son of Daniel and Helen Stanton Hoppes and a direct descendant of a Revolutionary soldier. His early life was spent on a farm and his formal education gained in the common schools.

Being mechanically minded, Mr. Hoppes left the farm while still a boy to gain experience in mills of which his father was a contractor and builder. During this period he studied engineering through a correspondence course conducted by Professor Robert R. Thurston of Cornell University. In 1880 he went to Springfield, Ohio, where he was prominently active as manufacturer, industrialist and civic leader through the long period to his death on July 12.

Mr. Hoppes' public career started on the day he first arrived in Springfield when he made a street-corner speech in defense of installing a city waterworks system. He became a member of the City Council in 1887, was appointed a commissioner of police and fire in 1895, helped draft the City Charter for commission—manager form of city government, was elected and served as city commissioner for six years. He was an active worker in the Springfield Improvement League, the Chamber of Commerce, the Board of Trade, the Commercial Club and was instrumental in building up many of the prominent industrial establishments now prospering in Springfield.

Hoppes Heater Co. was organized by Mr. Hoppes in 1882 and in '85 he patented the Hoppes steam feedwater purifier. The Hoppes Manufacturing Co., with Mr. Hoppes as president, was established in 1886, and took over the Heater Co. Other important steam power plant equipment patented, designed and developed by Mr. Hoppes and his associates include the Hoppes deaerating feedwater heater, the Hoppes V-notch meter and several types of steam and oil separators. The devices which he invented and patented during his lifetime numbered 47.

Mr. Hoppes' contribution to the art of efficient production of power through the development and manufacture of heat saving equipment places him among the foremost of the modern industrial pioneers.

Matthew S. Sloan

MATTHEW SCOTT SLOAN, chairman of the board and president of the Missouri-Kansas-Texas Lines died in a New York hospital on July 14 of a heart attack. Mr. Sloan had been one of the nation's leading utility executives and financiers having at one time headed five companies which together comprised the larg-

"Jim kept harping on CORROSION RESISTANCE ... as if THAT was all that mattered!"

"I was doing different 'fishing' last week . . . for a *metal*.

"Hauled in plenty of suggestions, too. Only none of 'em would fit my job.

"Most of 'em had only half the properties I needed. Some had only one. Like Jim's—*all his metal could offer was corrosion resistance.*

"But what good's corrosion resistance if the metal can't stand the load? And, what good is strength if the metal corrodes away before next summer?

"*Sure*. I needed corrosion resistance. But this job also called for a metal that was non-magnetic and strong . . . tough . . . hard as a heat-treated alloy steel.

"And, just to make the problem a little more difficult . . . the metal had to be readily machinable.

"Then . . . someone suggested the INCO Nickel Alloys.

"*That was the tip I needed!*

"All of them had Jim's corrosion resistance, *plus* strength, toughness, hardness and machinability. And each one also had certain *specialized* properties.

"Knowing the properties I needed, it was easy to run down the list and choose the INCO Nickel Alloy that had exactly the combination of properties needed — heat-treatable *'KR' Monel*.

"It worked as though it'd been made especially for my job!"

A multi-ton unit . . . or a pin-like fastening. Size imposes no limitations when you use INCO Nickel Alloys to build in the "performance" you plan.

Investigate these alloys whenever you need tough metals for tough jobs. Each offers a different (and hard-to-find) combination of properties.

Tell us the alloy that interests you, and we'll mail more information. Or, send for "List B-100," listing over 100 bulletins which explain the properties and applications of the INCO Nickel Alloys. The International Nickel Company, Inc., 67 Wall St., New York 5, N.Y.

	MONEL	"R" MONEL	"K" MONEL	"KR" MONEL	"S" MONEL	NICKEL	"Z" NICKEL	INCONEL
CORROSION RESISTANCE	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
STRENGTH	GOOD	GOOD	HIGH	HIGH	GOOD	GOOD	HIGH	GOOD
TOUGHNESS	GOOD	GOOD	HIGH	GOOD	GOOD	HIGH	HIGH	HIGH
HARDNESS	GOOD	GOOD	GOOD	GOOD	HIGH	FAIR	HIGH	GOOD
MACHINABILITY	GOOD	HIGH	GOOD	HIGH	GOOD	GOOD	GOOD	GOOD
NON-GALLING	NO	NO	NO	NO	HIGH	NO	NO	NO
SPRING PROPERTIES	GOOD	NO	HIGH	NO	NO	GOOD	HIGH	HIGH
ELEC. CONDUCTIVITY	POOR	POOR	POOR	POOR	POOR	GOOD	GOOD	POOR
HEAT RESISTANCE	GOOD	GOOD	GOOD	GOOD	HIGH	GOOD	GOOD	HIGH
HEAT TREATABLE	NO	NO	YES	YES	YES	NO	YES	NO
NON MAGNETIC	NO	NO	YES	YES	YES	NO	NO	YES

NICKEL (INCO TRADE MARK) **ALLOYS**

MONEL* • "K" MONEL* • "S" MONEL* • "R" MONEL* "KR" MONEL* • INCONEL* • "Z" NICKEL* • NICKEL

Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)

*Reg. U. S. Pat. Off.

This stuffing box won't need repacking for a long, long, time . . .

PALMETTO Packings stop leaks and do not wear out the rod or shaft.

Complete internal lubrication reduces friction, saves wear of both packing and equipment and keeps the packing soft and resilient for extremely long periods of time.

The result is long, economical service, saving time, material and trouble.

There is a PALMETTO Packing available for every condition of service.

Write for descriptive literature.

GREENE, TWEED & COMPANY

Bronx Blvd. at 238th St., New York 66, N. Y.
Plants at New York, N. Y. and North Wales, Pa.

For Final Victory—Buy MORE War Bonds

PALMETTO

PALMETTO for steam, water, air • PELRO for oils • CUTNO for alkalis • SUPER-CUTNO (blue asbestos) for acids. • KLERO for foods

Self-Lubricating PACKINGS

est electric light and power system in the world. These included Brooklyn Edison Co., the New York Edison Co., the United Electric Light & Power Co., the New York and Queens Electric Light and Power Co., and the Yonkers Electric Light and Power Co.

Mr. Sloan was born in Mobile, Ala., September 5, 1881. From the Alabama Polytechnic Institute, he received an M.S. degree in 1902, E.E. in 1911 and Dr. Eng. in 1929. From 1902 to 1906 he worked for the General Electric Co. at Schenectady, then became associated with the Birmingham Railway Light & Power Co. until 1914 when he became vice president and general manager of the New Orleans Railway & Light Co. for three years, accepting a similar position with the New York Edison Co. in 1917 and advancing to its presidency in 1928. During the succeeding 16 yr he has given service as executive head to some thirty outstanding companies in the fields of electric power, railway, manufacturing and finance.

Daniel C. Smith

DANIEL CRANFORD SMITH, 79, former treasurer and trustee of the New School for Social Research and vice president and co-founder of Oakite Products, Inc., died June 23.

Mr. Smith had been interested in the New School since it was founded in 1919 at 10th Ave. and 23rd St. in New York City and devoted to the cause of higher adult education. He provided the site for the present modernistic five-story building in 1929 by purchasing five brownstone tenements on 12th St. and presenting the lots to the school.

Mr. Smith was born in Brooklyn, November 23, 1865, and was graduated from Princeton University in 1886. He became a certified public accountant for the American Cotton Co. and later served as auditor for Tuskegee and Hampton Institutes, Negro universities.

In 1909 he became co-founder with David C. Ball of Oakite Products, 22 Thames St. He was treasurer of the New School from 1932 until his retirement last January.

Herbert J. Winn

HERBERT J. WINN, Chairman of the Board of the Taylor Instrument Cos., died unexpectedly at his home, Rochester, N. Y., on June 27. He would have been 75 on July 12.

Mr. Winn began his career with the company in 1893, starting as a "boy of all work" and becoming over the years one of the country's great industrialists. In 1898, he was sent to London to open a branch office and during the period of his six years' stay there, purchased the Short and Mason Co., Ltd., presently one of England's prime producers for war. In 1913, upon the death of J. Merton Taylor, he was elected president of the company, a position which he held until 1938 when he was made chairman of the board.

Mr. Winn's activities outside the business were numerous. At various times he was chairman of the board of directors of the Lincoln-Alliance Bank and Trust Co., a director of

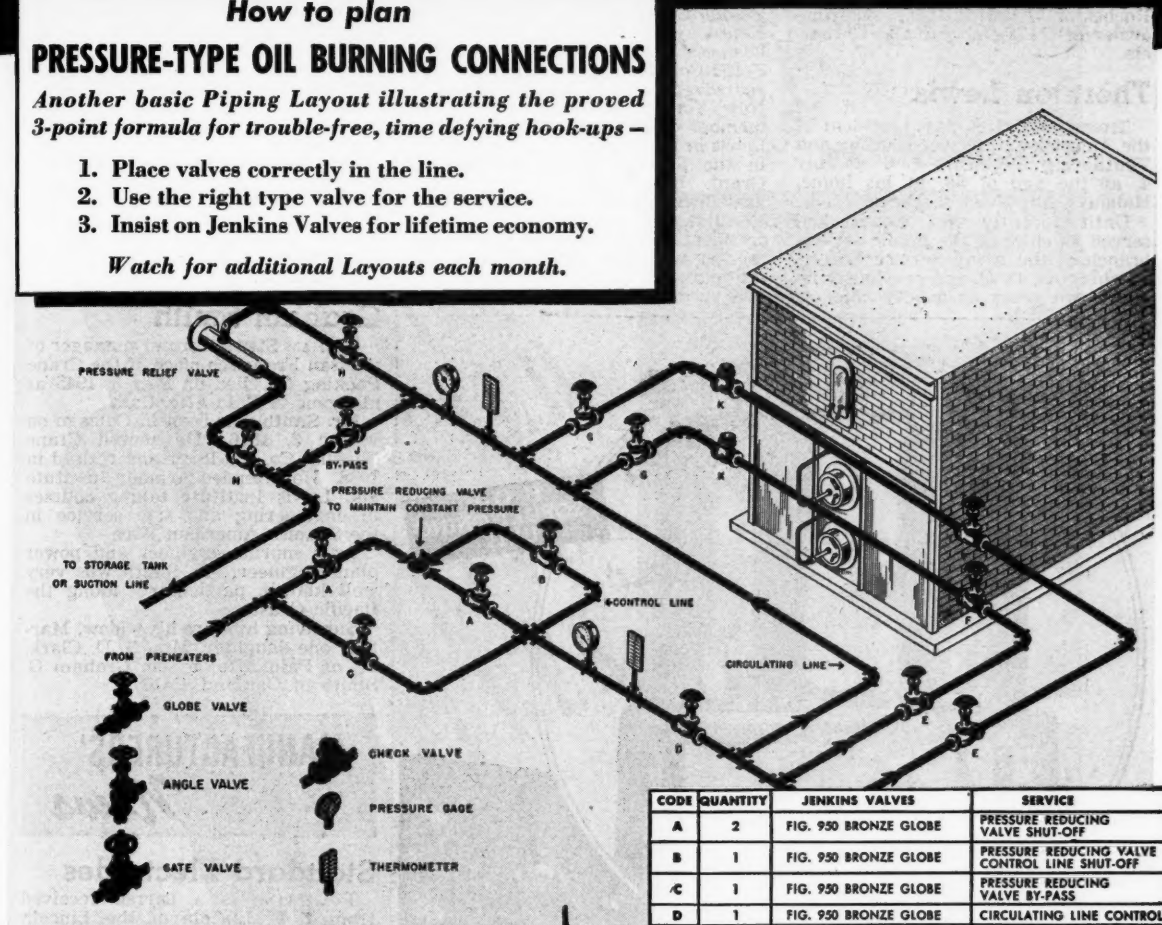
Jenkins PRACTICAL PIPING LAYOUTS 3

How to plan
PRESSURE-TYPE OIL BURNING CONNECTIONS

Another basic Piping Layout illustrating the proved 3-point formula for trouble-free, time defying hook-ups –

1. **Place valves correctly in the line.**
2. **Use the right type valve for the service.**
3. **Insist on Jenkins Valves for lifetime economy.**

Watch for additional Layouts each month.



VALVE RECOMMENDATIONS
For details—and valves to suit varying conditions—see Jenkins Catalog.

CODE	QUANTITY	JENKINS VALVES	SERVICE
A	2	FIG. 950 BRONZE GLOBE	PRESSURE REDUCING VALVE SHUT-OFF
B	1	FIG. 950 BRONZE GLOBE	PRESSURE REDUCING VALVE CONTROL LINE SHUT-OFF
C	1	FIG. 950 BRONZE GLOBE	PRESSURE REDUCING VALVE BY-PASS
D	1	FIG. 950 BRONZE GLOBE	CIRCULATING LINE CONTROL
E	2	FIG. 950 BRONZE GLOBE	BURNER SHUT-OFF
F	2	FIG. 741G BRONZE NEEDLE FIG. 950 BRONZE GLOBE	BURNER REGULATOR
G	2	FIG. 950 BRONZE GLOBE	CIRCULATION CONTROL AND SHUT-OFF
H	2	FIG. 950 BRONZE GLOBE	PRESSURE RELIEF VALVE SHUT-OFF
J	1	FIG. 950 BRONZE GLOBE	PRESSURE RELIEF BY-PASS
K	2	FIG. 830 BALL CHECK FIG. 756 REGRINDING LIFT CHECK	BACK-FLOW PREVENTION

SYSTEMS USING STEAM to preheat oils, fired under pressure, are in wide use today. This layout is arranged for the multiple-burner type boiler. In the event of oil leaks or other failure, the valves are arranged to provide flexibility of shut-offs. To prevent complete boiler shutdowns in an emergency, by-passes are provided around the pressure reducing or relief valves. Constant and uniform oil pressure is maintained by an automatic regulating valve.

MANY PATTERNS AND PRESSURE RANGES of Jenkins Valves, other than those indicated, can be used for a layout of this type, according to the particular installation. Consultation with accredited piping engineers and contractors, when adapting these suggestions to your own requirements, or when planning any major piping installations, is recommended.

COPIES OF THIS LAYOUT, enlarged with details of valve specifications, also future "Piping Layouts" as they appear, will be sent at your request.

SELECT THE VALVES you need from one source, and save time and trouble. The Jenkins catalog lists over 600 different patterns. With rare exceptions, you will find just the valves you want . . . made by Jenkins valve *specialists* – your assurance of the lowest cost in the long run.

Jenkins Bros., 80 White Street, New York 13; Bridgeport; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Ltd., Montreal; London, England.

LOOK FOR THIS JENKINS Jenkins Bros **DIAMOND MARK**
SINCE **1864**

JENKINS VALVES

For Domestic, Commercial, Engineering and Industrial Service . . . In Bronze, Iron, Cast Steel and Corrosion-resisting Alloys . . . 125 to 600 lbs. pressure.

Sold Through Reliable Industrial Distributors Everywhere

the Pfaudler Co., and a trustee of the Rochester Trust and Safe Deposit Co., the Community Chest and the Rochester Savings Bank. He was also president and treasurer of the Rochester Printing Co., one-time owner of the Democrat and Chronicle.

Thornton Lewis

THORNTON LEWIS, past president of the American Society of Heating and Ventilating Engineers died on July 4, at the age of 58, at his home, Holiday Hill, Newton, Penna.

Until recently Mr. Lewis had served as chief of the public service branch of the Army Service Forces, Washington, D. C. and previously he spent two years as deputy chief of the procurement service branch, U. S. Army Ordnance Department.

Mr. Lewis was born in Versailles, Ky., May 6, 1887, attended the public schools of Frankfort, Ky. and graduated from the University of Kentucky in 1906. He started his business career with the Buffalo Forge Co., Buffalo, N. Y. and for five years represented that company in New York. For two years was a member of the firm of Murphy and Lewis in Philadelphia, then a partner in the firm of Lewis, Robinson & Grant. In 1921 Mr. Lewis became identified with the York Heating and Ventilating Corp. and later was its president and general manager. After merger with the Carrier Corp., for six years Mr. Lewis served as executive vice president and later became president of Pulp Products Co., New York. He retired from active business in 1937.

Mr. Lewis joined the ASHVE in 1919 and did outstanding work as chairman of the committee on research, as a council member and as head of the executive and finance committes. In 1929 he became president of the Society and during his many years of active service, he was a leading figure in the activities of the Society.

Mr. Lewis leaves a widow, Elsie V. Lewis at Newton, Penna., three sons, Thornton Jr., North Plainfield, N. J., Lt. Daniel G., USNR, Seattle, Lt. F. Allen, in the Army and a daughter, Mrs. Kent J. Terry, New Hope, Penna.

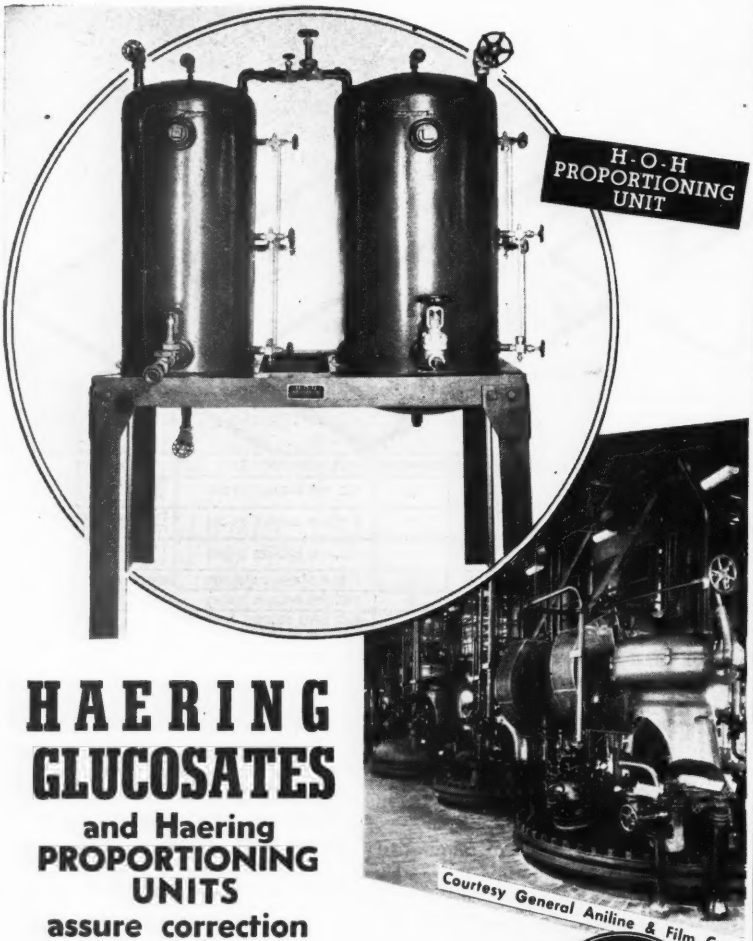
Graham Smith

GRAHAM SMITH, former manager of the San Francisco office of the Crane Packing Co. died on May 5, 1945 at his home in Palo Alto, Calif.

Mr. Smith was born in Chicago on March 3, 1876. He served Crane Packing Co. for 18 yr and retired in 1938. He attended Armour Institute and Lewis Institute taking courses in engineering and saw service in the Spanish American War.

As a marine engineer and power plant engineer, Mr. Smith was very well known, particularly along the Pacific Coast.

Surviving him are his widow, Martha; one daughter, Mrs. G. D. Clark, Jr. of Palo Alto; a son, Graham G. Smith of Oakland, Calif.



HAERING
GLUCOSATES
and Haering
PROPORTIONING
UNITS
assure correction
and control of
CORROSION,
SCALE, ALGAE
in Industrial Plants

WRITE FOR
"H-O-H
WATER
STUDIES"

WE
READ
WATER

D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Ill.

MANUFACTURERS' *News*

Standard Electrodes

FOLLOWING IS A LETTER received from J. F. Lincoln of the Lincoln Electric Co. advocating the adoption of a standard covering welding electrodes. The letter is reproduced in its entirety:

"Industry in general, and the welding industry in particular, are and have been greatly handicapped by the lack of a real technical standard covering electrodes.

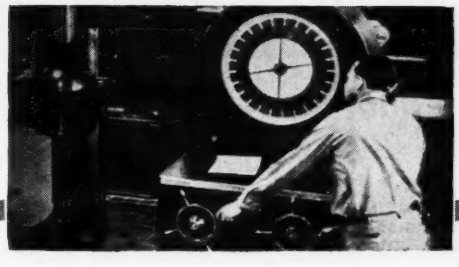
"True it is, there have been in existence for some years a so-called standard which actually might be termed a 'buyers' guide', known as 'Tentative Specifications for Iron and Steel Arc Welding Electrodes' published by the AWS. However, even in this long and complicated 'buyers' guide' there are so many discrepancies with ambiguous and contradictory statements that it is rendered entirely unsatisfactory. Let me cite a few examples.

"To qualify any electrode for any classification, the tests are so complicated and so costly as to render them useless in manufacturing practice. They are too costly to be repeated periodically as a check on manufacturing standards.

"Tests are required on all sizes of 5/32 in. and above; but note—no tests are required on 1/8 in. and smaller so why have tests on *each* larger size?

"A manufacturer cannot use the

SCIENCE helps to BUILD BETTER TUBES



NEVER being satisfied with the "best" is the motivating force of science. The same spirit prompts Globe to maintain complete chemical and physical laboratories for steel tube research and for production control. The scientific approach explains why uniformity and quality are so accurately controlled at Globe. Whatever the tube requirement, Globe usually has the answer, based on these essential facilities — practical experience, manufacturing skill and specialized knowledge. You can be sure of uniformity and quality when you specify Globe tubes — pressure, mechanical or stainless.

GLOBE STEEL TUBES CO., Milwaukee 4, Wis.

GLOBE STEEL TUBES

- ★ Pressure Tubes
- ★ Condenser & Heat Exchanger Tubes
- ★ Seamless Stainless Steel Tubes
- ★ Mechanical Tubing
- ★ Gloweld Welded Stainless Steel Tubes
- ★ Globeiron High Purity Iron Seamless Tubes

5022

same electrode for two or more classifications; this in spite of the fact that the ideal electrode, of course, is one which would fulfill all classifications.

"Then there are specifications as to the electrical resistance of the coating which certainly has nothing to do with the performance of the electrode.

"Also it says: 'The coating shall not have scabs, blisters, abnormal pockmarks, bruises or other surface defects that shall be injurious.'

"Just what is injurious?

"These are only a few of the idiosyncrasies of this 'buyers' guide'. Therefore, it can readily be seen that what is needed is a simple, easily understandable standard which would enable a manufacturer to manufacture to such standards consistently and would enable the purchaser to readily and easily test the electrodes if he wished to do so, to see if the manufacturer was conforming to the standards.

"Since there is no need for a weld stronger or better than the material to be welded, I suggest for mild steel which covers 90 per cent of the requirements, a simple standard something as follows:

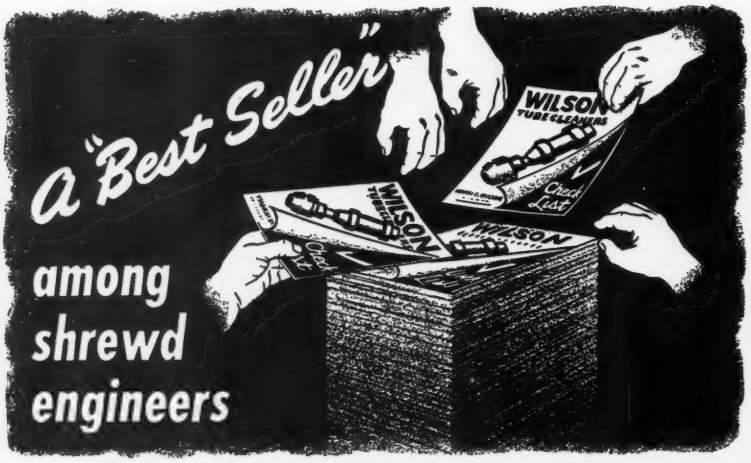
"The electrode shall be of such characteristics that it will withstand the following tests to be made any time a buyer might desire: (a)—A weld made in ⅜ in. or ½ in. plate of mild steel, planed to the same thickness as the parent metal, must break outside of the weld when pulled in a standard tension machine. (b)—On a section from the same plate mentioned in (a) welds to be bent in any way desired and elongation of 25 per cent in the outside fibers must show no fracture.

"It is quite evident that an electrode which will perform as indicated in these two tests will give a weld equal in physical qualities to the plate.

"With such a weld obviously the matter of porosity is of no consequence. However, if it should be desired to cover the question of porosity, a simple test could be made as follows: a fracture shall be made through the weld. On a straight line through the fractured weld there shall be voids of no more than 5 per cent cumulatively.

"There is no question but that an electrode which will withstand the above very simple tests will be satisfactory in welding mild steel, so why complicate matters?

"It seems to me that this is a question to which the Filler Metal Committee of the American Welding Society, 33 West 39th Street, New York City, should give proper attention."



—another reprint just completed . . . get your free copy now!

Yes, the same Wilson Tube Cleaners Check-List that found such wide acceptance in its original edition, has just been reprinted—and it's available to you for the asking.

This six-page folder gives valuable hints on tube cleaner maintenance and operation that will show you how to save wear and tear on your tube cleaning equipment. These suggestions will go a long way toward making your present equipment last longer and give better service.

Moreover, there is a two-page Tube Cleaner Selection Guide that will help you choose the right Wilson Tube Cleaning Motor, Cutter Head and accessory to get your job done faster and more efficiently with minimum damage to tube walls.

Your copy of the Wilson Tube Cleaners Check-List will be sent on request—and without obligation, of course.

wilson

TW-691

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

Cutler-Hammer Broadens Organization

AT THE ANNUAL MEETING of the board of directors of Cutler-Hammer, Inc., held June 15, the management organization was broadened by the election of the following officers: F. R. Bacon, chairman of the board; H. F. Vogt, chairman of the executive committee; G. S. Crane, president; H. F. Vogt, vice president and treasurer; and J. C. Wilson, vice president and secretary.

The following additional officers were elected: P. B. Harwood, vice president in charge of engineering; P. S. Jones, vice president in charge of sales; Philip Ryan, vice president in charge of manufacturing; E. W. Seeger, vice president in charge of development and assistant secretary; M. R. Fenno, assistant treasurer; and J. C. Springer, assistant secretary.

F. R. Bacon and G. S. Crane were elected as the other members of the executive committee.

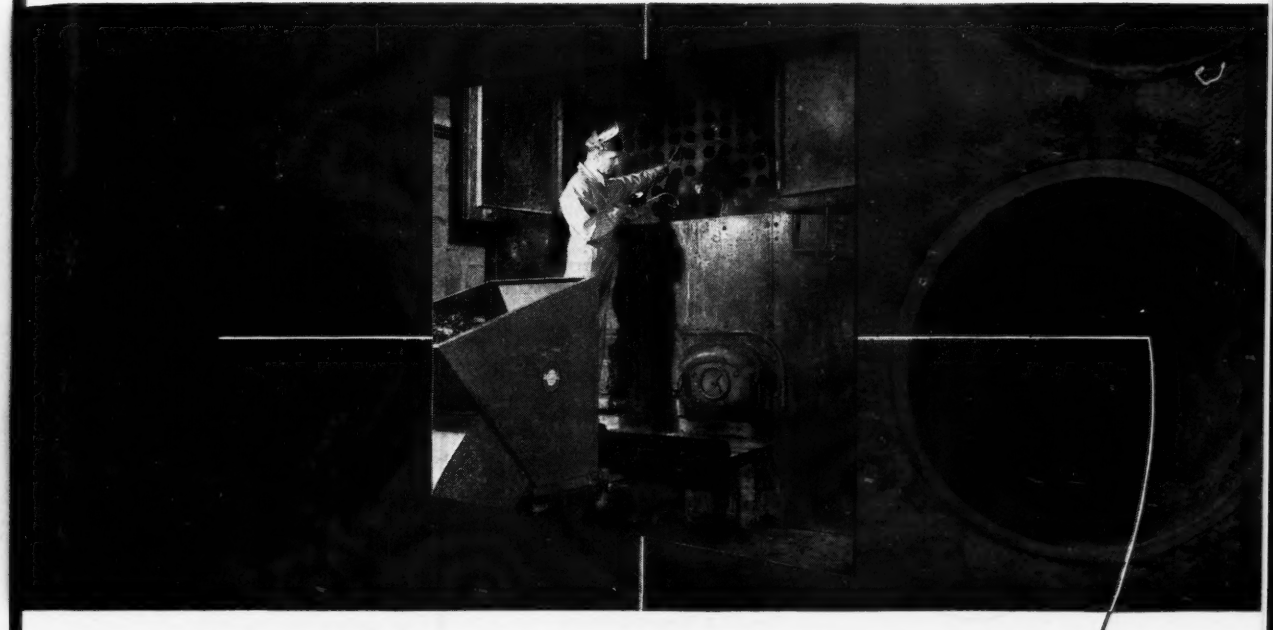
New G. E. Plant

TIFFIN, OHIO, is to be the site of a General Electric Co. plant for the manufacture of small motors for electrical appliances and ballasts for fluorescent lamps. Another site is being considered for another new manufacturing plant, both to be operated under the management of the company's Fort Wayne works. In making this announcement M. E. Lord, manager of the local plant, said buildings will be designed, equipment ordered and construction started as quickly as it is possible to do so.

"Employes of the Fort Wayne works have long observed the year-by-year increasing demand for fractional-horsepower motors for appliances and have seen the plant's facilities expanded until they have overrun the areas available for production," Mr. Lord's statement said. "The growth in fluorescent ballast production has been even more rapid."

DOWELL

CHEMICAL SCALE REMOVAL SERVICE



SCALE REMOVED . . . . . IN 12 HOURS! BY SPECIALISTS IN POWER RESTORATION

Exceptional time saving and thoroughness, with complete safety! These are advantages offered you by the Dowell chemical method of removing power-stealing scales and sludges from your heat exchange equipment.

The above pictured boiler was returned to designed operating efficiency in 12 hours by the chemical removal of the calcium phosphate sludge which insulated the heat transfer surfaces. The rapid, efficient Dowell method, with a specific solvent for each deposit and type of metal, produced these results.

This example is typical. It illustrates how this pioneer service organization scientifically restores power. The complexity and size of the equipment offers no problem to Dowell engineers who have years of experience in the chemical removal of all types of scales and sludges from heat exchange units.

Dowell Service offers the additional advantages of extensive research and technical facilities of The Dow Chemical Company, parent organization of Dowell. This Dow-Dowell combination, which has been responsible for so many improvements in the methods of removing scales and sludges, will continue to better serve the plants of American industry.

Write, wire or phone the nearest Dowell office for a free estimate and your copy of "More Power to America's Industry", a new booklet containing much interesting information on Dowell Chemical Scale Removal Service.

DOWELL INCORPORATED
Subsidiary of The Dow Chemical Company
Executive Office, Midland, Michigan
GENERAL OFFICE, TULSA 3, OKLAHOMA

New York • Philadelphia • Cleveland • Chicago • St. Louis • Houston
Kansas City • Wichita • Mt. Pleasant, Michigan • Salem, Illinois

MANUFACTURERS' *Personals*

Norman C. Hurd has been appointed manager of the Cincinnati Manufacturing and Repair Department of the Westinghouse Electric Corp. Mr. Hurd has been acting manager since last December.

General Electric Co. has made the following appointments: H. M. Jalonack appointed assistant to manager, transformer division, and is succeeded as manager sales, distribution transformer section by C. E. Burke of Fort Wayne, Ind.; D. F. Roloff has been appointed assistant manager sales, succeeding Mr. Burke; and E. V. Dillon, formerly assistant manager sales of regulators, has been appointed manager sales, feeder voltage regulator section.

E. J. Hergenroether, recently resigned chief of the metallurgical branch of the steel division of War Production Board at Washington, D. C., has resumed his duties with the development and research division of the International Nickel Co. Inc., New York. Mr. Hergenroether will be in charge of the division's automotive steel development and will make his headquarters in Detroit at the company's field office there.

S. Riley Williams has been appointed director of international business by Worthington Pump and Machinery Corp. He will be responsible for the administrative direction of all Worthington's foreign and export activities and will supervise the operation of the corporation's associated companies in foreign countries.

Carl B. McLaughlin will head up the recently established engineering service division of Tube Turns, Inc., Louisville, Ky. McLaughlin formerly was associated with Tube Turns' Pittsburgh office.

Jack C. Lyle has joined the Ludlow Valve Manufacturing Co., Inc., of Troy, N. Y., to take charge of its southern territory.

David F. Austin, vice president in charge of sales of Carnegie-Illinois Steel Corp., has been appointed acting vice president, sales, of United States Steel Corp. of Delaware.

Fred W. Deutsch is now associated with Builders-Providence, Inc. (Division of Builders Iron Foundry), Providence, R. I. as assistant sales manager and will be concerned with sales of Builders' water and sewage works equipment and also the company's recording, indicating and controlling instruments. Mr. Deutsch will make his headquarters in Providence, R. I.

George H. Dowding has been promoted to director of industrial relations, Carnegie-Illinois Steel Corp., Chicago district, succeeding Peter V. Martin, who leaves this U. S. Steel subsidiary company for assignment abroad with the Foreign Economic Control Council. Mr. Dowding has been associated with the company since January, 1919. He held various positions in Gary and South Chicago plants of the company before becoming superintendent of industrial relations at the latter plant 4 years ago. Earl H. Fyler, formerly assistant to the Chicago district director of industrial relations, has been appointed to succeed Mr. Dowding at the South Chicago plant.

Herman J. Schorle has been named works manager of the Holyoke Works of Worthington Pump and Machinery Corp. He succeeds Harry A. Feldbush, who has assumed administrative duties at the corporation's general offices in Harrison, N. J. Schorle was former executive engineer at Holyoke and assistant works manager.

W. F. Boyle has been appointed assistant to the vice president to direct the Pacific Coast district office of the Baldwin Locomotive Works and the Pelton Water Wheel Co. Mr. Boyle will temporarily assume the duties formerly performed by F. R. Kohnstamm at the San Francisco Headquarters of Baldwin and Pelton, Kohnstamm having been temporarily relieved due to illness.

After three years with the Army Air Forces Training Command, Captain Don Allshouse has been placed on inactive status and has rejoined Northern Equipment Co., Erie, Pa., as advertising manager, a position held for 14 years prior to entering the service.

Charles A. Butcher, formerly with Westinghouse, has been recently appointed assistant general manager of the Crocker-Wheeler Division, Joshua Hendy Iron Works, Ampere, N. J.

RODA

High grade gas, by-product and steam coal from Wise County, Va., on the Interstate Railroad.

DENDRON

High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA

High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

PREMIX STOKER

A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

COKE

Roda and Stonega from Wise County, Va., and Connellsville Coke from Pennsylvania.

CRITERION COAL

High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

CROZER

Genuine Third Vein Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railroad.

Admiralty Coal

Genuine New River Smokeless, Beckley or Sewell seam from Raleigh County, W. Va., C. & O. and Virginian Railroads.

Old Kentucky

Hazard No. 4 and No. 7 steam and domestic coal from Wiscoal, Knott County, Kentucky, on the L. & N. Railroad.

CHARMCO

Unexcelled Steaming Coal from the Fire Creek Seam in Greenbrier County, W. Va., originating on the N. F. & G. R. R.

ANTHRACITE — Hazle Brook Premium

. . . Raven Run

General Coal Company

123 SOUTH BROAD STREET, PHILADELPHIA 9, PA.

BRANCHES:

BLUEFIELD, W. VA. BOSTON BUFFALO CHARLOTTE, N. C.
CINCINNATI DETROIT NEW YORK NORFOLK PITTSBURGH

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company — "Bridgeport" BRASS CO. — *Headquarters for BRASS, BRONZE, and COPPER*

Influence of Temperature on Corrosion Rate & Water Composition

Heat accelerates practically all the reactions involved in the mechanism of corrosion. Chemical activity is increased by raising the temperature and diminished by lowering it. For example, it may be roughly stated that a temperature rise of approximately 20°C. (36°F.) will double the rate of corrosion. While the effect of temperature is not always so great, frequently it is even more pronounced.

The effect of temperature on corrosion rate generally depends on the nature of the corroding medium. Figure 1 shows the relationship in the case of brass in a 3% sodium chloride solution.

Many power plant engineers keep a careful record of incoming and outgoing cooling waters and incoming steam temperatures in condenser installations because they realize that a unit operating at too high a temperature may fail prematurely. Increased temperature may be the principal reason for unsatisfactory tube life.

The higher temperatures of cooling waters during the summer is one of the factors contributing to more rapid corrosion during that season. Instances have been reported where new condenser tubes installed during the winter season have given longer service than tubes installed during the summer. This difference in performance occurs because the type of protective film which forms on metal in cold water is generally thinner and more continuous than one which forms in warm water. Warm water substantially increases the susceptibility to pitting. As a result of pitting, the useful life of a condenser tube may be considerably shorter than that indicated by the overall corrosion rate. Therefore, when operating conditions involve circulating water of higher than average temperature it is of the greatest importance to choose the right condenser tube alloy. Realizing this, engineers are now specifying more corrosion resisting alloys such as Bridgeport's Duronze IV (aluminum bronze) for a combination of severe corrosion conditions. For example, this alloy should stand up well in power plants situated in the harbors of southern ports or tropical countries where higher temperatures are added to the problems of pollution by sewage, acid wastes and other contaminants. Ordinary alloys fail prematurely under such conditions. Duronze IV and cuzinal (aluminum brass) stand up exceptionally well under such conditions. Every precaution should be taken to prevent air inclusion and reduce turbulence since the formation of gases resulting from increased bacterial activities due to higher temperatures accelerates impingement corrosion resulting from these factors.

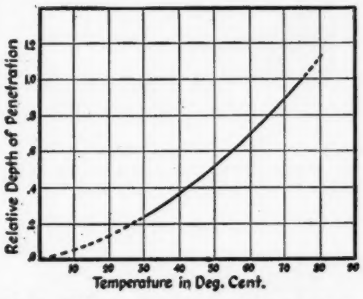


Fig. 1—Effect of Temperature Only on Rate of Corrosion.

Temperature May Affect Water Composition

Figure 2 shows the variation in temperatures and the rate of corrosion in an estuary plotted against the seasons of the year. It is evident that as the temperature rises and falls, the corrosion rate also rises and falls with this difference that, when bacterial activity is high there is an increase in the gas content of the water—such as CH_4, NH_3, CO_2 and H_2S. The CO_2 and H_2S are formed in sufficient quantity to have a marked corrosive action.

The presence of gases such as H_2S may destroy the protective film which has been built up during the cool months when the water composition is more nearly normal.

Selection of Proper Condenser Tube Alloy Pays Big Dividends

In recent years power plant and marine engineers have been paying more attention to the character and properties of the condenser and heat exchanger tubing which they have been using. Greater overall economy in the long run is brought about by the use of the best available alloy regardless of cost. The saving from reduced maintenance, increased efficiency from cleaner tubes and the reductions in shut-downs and interrupted service, soon more than pay for the difference between the best available alloy and ordinary materials. Considerable data on corrosion, water composition, modern condenser tube alloys together with methods of installing and removing condenser tubing, is published in Bridgeport's 112-page Condenser Tube Manual which is available for the asking. Write for your copy today.

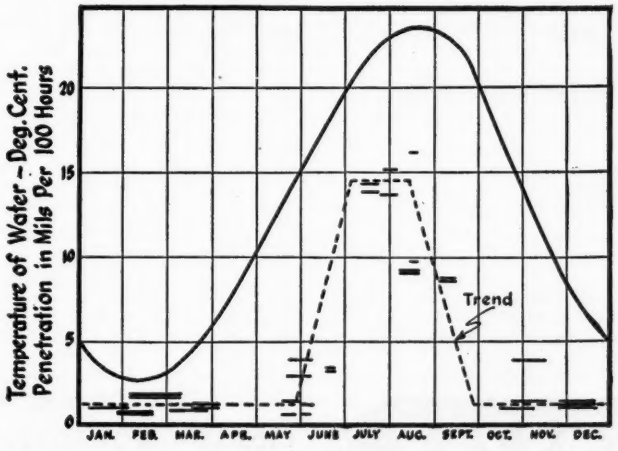


Fig. 2—Effect of Temperature and Bacterial Activity on Rate of Corrosion in Impingement Corrosion Test—Smooth curve records mean water temperature. Short horizontal lines represent results of individual tests, both magnitude and duration. Dotted lines indicate approximate trend of results.

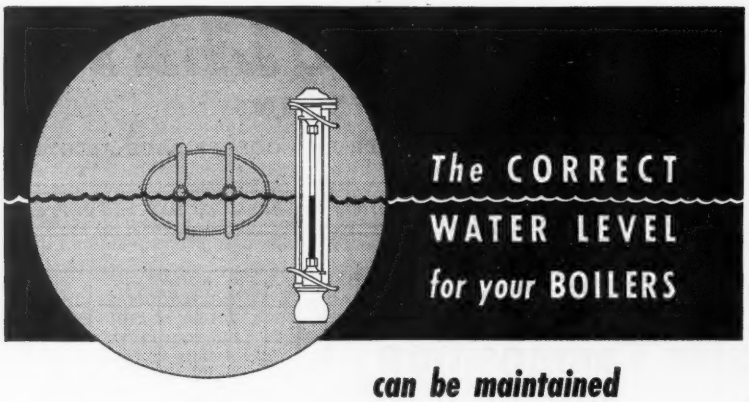
Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

ARMY E NAVY

ESTABLISHED 1865



can be maintained

CONTINUOUSLY, AUTOMATICALLY, ACCURATELY
under* ALL LOAD CONDITIONS *with

HENSZEY *Boiler Feed* REGULATORS

The Henszey Regulator is easily installed right in the feed line — no additional structural supports are needed. Once installed and set for operation, no further attention is necessary — nothing to get out of order — nothing to rust.

Avoid the hazards of high, as well as low water levels — plan now for positive, accurate boiler water level control . . . investigate Henszey Boiler Feed Regulators.

HENSZEY CO. Dept. C8 Watertown, Wis.

The Henszey Boiler Feed Regulator is made for pressures up to 600 pounds and in pipe sizes up to four inches.

HENSZEY

BOILER FEED REGULATORS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Feed Water Meters • Flow Indicators • Proportioning Valves

NEWS *from* THE FIELD

Professional Engineers Must Register in Illinois

ON JULY 20 GOVERNOR GREEN signed House Bill No. 337 making it a law which requires the registration of all persons practicing or offering to practice all branches of professional engineering in the state of Illinois. Designed as a safeguard to life, health and property, the law requires those applying for a professional engineer's license to submit evidence that they are qualified so to practice, and to register with the Illinois Department of Registration and Education.

To receive a certificate of registration, a person must be of good moral character and temperate habits, and successfully pass an examination designed to show knowledge and skill equivalent to that attained through graduation from an engineering college, and have had 8 yr or more of professional engineering experience; or be an engineering college graduate and have 4 yr or more of experience.

Engineers are permitted one year from July 20, 1945, or until July 19, 1946, before penalties will be enforced. Those now practising can, without a written examination, get licenses within one year by submitting evidence of good character and ability. Special time concessions are given to those in the Armed Services.

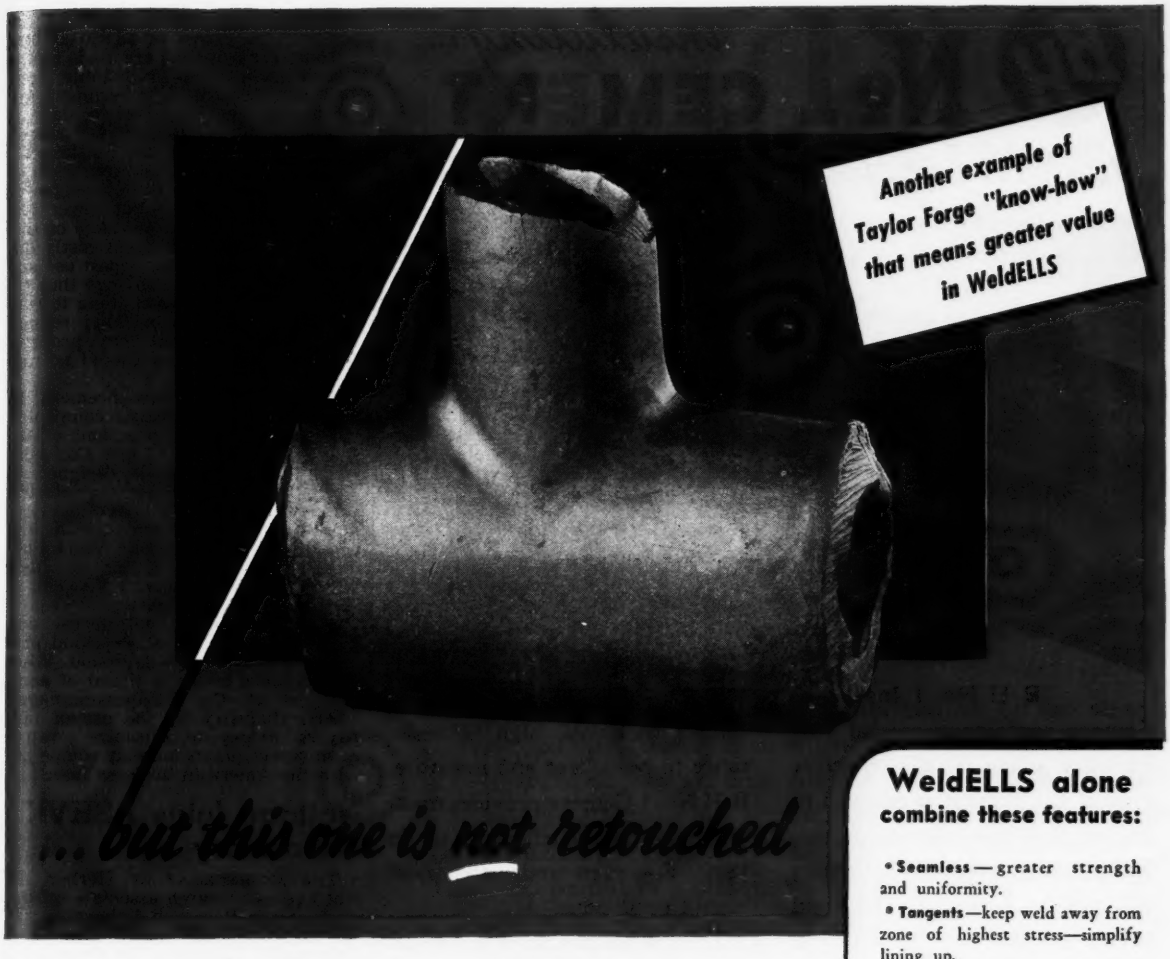
Those ordinarily designated as operating engineers whose duties do not require process planning or the design of physical parts are not required to register.

New AIEE Officers

DR. WILLIAM E. WICKENDEN, president, Case School of Applied Science, Cleveland, Ohio, was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1945, as announced at the annual meeting of the Institute held in New York, June 27. The other officers elected were: vice presidents E. S. Fields, Cincinnati, Ohio; H. B. Wolf, Charlotte, N. C.; L. M. Robertson, Denver, Colo.; F. F. Evenson, San Diego, Calif.; F. L. Lawton, Montreal, Canada. Directors: J. M. Flanigan, Atlanta, Ga.; J. R. North, Jackson, Mich.; Walter C. Smith, San Francisco, Calif. National treasurer, W. I. Slichter, New York, N. Y. (reelected).

Utility Companies' Policies Toward Federal Power Projects

IN A JOINT STATEMENT dated July, 167 of the nation's electric light and power companies made known their position with regard to proposed river developments by the United States Government. These developments, providing for the creation of the Missouri Valley Authority and other projects similar to TVA, as well as the completion of several already in oper-



★ *A few months ago we pictured in this publication a heavy-wall tee with a remarkably long outlet—so long in fact that a few of our friends were a little skeptical and implied that we had perhaps over-extended our poetic license, as well as the outlet, in retouching the photo.*

Well . . . this one, as you can plainly see, is not retouched. The tee was photographed before machining just to show what can be done with hot metal if you know how.

YES, "*if you know how.*" . . . And it will pay you to keep this matter of "know-how" in mind when you choose standard welding fittings. The need for unusual knowledge and highly specialized skills may be less apparent in regular fittings than in specials like this, but make no mistake: it is *no less essential.*

That is why we have cited this and many other unusual jobs which testify so eloquently to the "know-how" of Taylor Forge. This knowledge has enabled us to put into WeldELLS and other Taylor Forge welding fittings every feature wanted by everyone from the pipe designer to the welder.

In fact, you will see the evidences of this in every WeldELL . . . in the strength features like the selective distribution of extra metal where strains are greatest . . . in the convenience features like the tangents, the quarter-marked ends, the machine-tool bevels, the extremely accurate dimensions. Indeed, you will see that

WeldELLS have everything

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P.O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

B-H No. 1 insulating CEMENT

Your No. 1 choice for RUST RESISTANCE

B-H No. 1 Insulating Cement contains a special rust inhibitor which is fully effective even if the cement is allowed to dry out slowly on cold equipment. The metal surfaces which it covers will not be corroded. The bond between metal and cement will remain firm.

In *every* way B-H No. 1 Insulating Cement is ideal for maintenance work, especially for valves, fittings and irregular surfaces, large or small, and as a finish over blanket and block insulations.

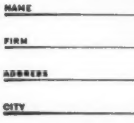
Because its basis is nodulated *black* Rockwool, high in resistance to both heat and moisture, B-H No. 1 Cement provides maximum insulating efficiency up to 1800° F.—even under the most humid conditions.

It can be stocked without breakage or loss, is easily applied even by unskilled labor, and is fully reclaimable when used at temperatures not exceeding 1200° F.

THE COUPON BELOW will bring you full information and a practical sample of B-H No. 1 Cement.

Baldwin-Hill

SPECIALISTS IN THERMAL INSULATION PRODUCTS



Baldwin-Hill Co., 520 Klagg Ave., Trenton 2, N. J.

Send information on products checked below:

- ☐ Free sample of B-H No. 1 Cement
- ☐ No. 100 Pipe Covering—effective up to 1200° F. (for long runs overhead, underground, Diesel exhausts)
- ☐ Mono-Block—the one-block insulation for all temperatures up to 1700° F.
- ☐ Black Rockwool Blankets (felted between various types of metal fabrics)

NAME _____ POSITION _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

ation, entail an estimated initial expenditure in excess of $3,850,000,000.

Four specific points are made by the electric companies in defining their attitude toward these government undertakings: 1. Whenever a dam is proposed, all of its purposes should be clearly defined in the legislation—flood control, navigation, irrigation or power; 2. Government-produced power should be sold to existing power systems without special privilege or discrimination, so as to avoid costly duplication and to insure widest use and lowest rates; 3. Any savings thus effected should be passed along to consumers under state or other regulations; 4. Government may properly regulate business, but should not operate business.

In making the announcement on behalf of the 167 electric companies, C. Hamilton Moses, president of the Arkansas Power and Light Co., said: "This announcement is designed to clarify the position of the electric companies regarding river developments along the pattern of TVA. The companies have been wrongfully charged with attempting to block such valley developments.

"This is an injustice to the electric companies. We do not oppose any government project of this kind provided it is economically sound. What does concern us is the threat of annihilation of the business-managed electric industry by the use of taxpayers' money to subsidize government power plants unfairly competing with the American business man."

Nottage Joins ASHVE Laboratory

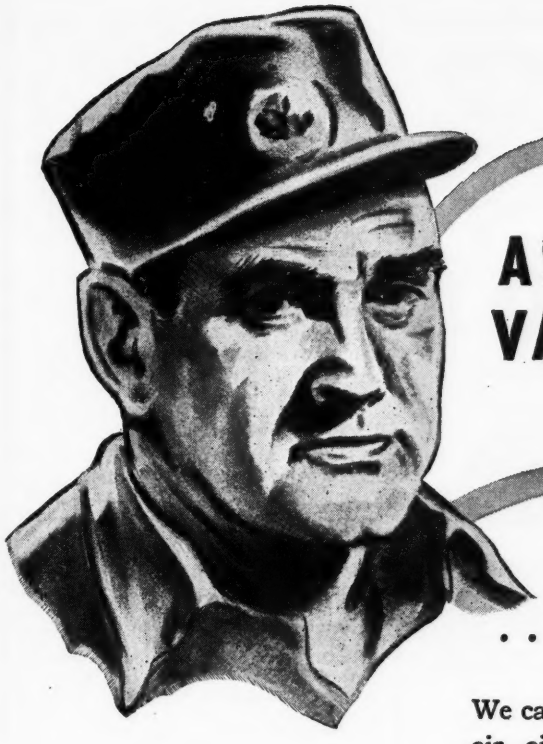
THE APPOINTMENT OF Herbert B Nottage as research associate on the staff of the Research Laboratory of the American Society of Heating and Ventilating Engineers, at Cleveland, Ohio, became effective July 1.

Mr. Nottage received his Bachelors degree in Mechanical Engineering with honors in 1937 and his Masters degree in 1939 from the University of California. During this period he worked for some time as a research assistant in the department of mechanical engineering on the cooperative research studies on cooling towers sponsored by the ASHVE.

From September, 1939, to August, 1941, he was instructor in mechanical engineering at the Illinois Institute of Technology, Chicago, Ill., and in August, 1941, he joined the research and development engineering staff of Pratt and Whitney Aircraft, East Hartford, Conn., and has been working there on problems in thermodynamics, heat transfer and fluid mechanics.

In 1943 and 1944 he was chairman of the ASHVE technical advisory committee on cooling towers and has been, for the past three years, secretary of the heat transfer division of the American Society of Mechanical Engineers.

In a recent report of the A. F. Davis Welding Library, it is stated that over 10,000 patents concerning welding equipment and the patented applications of welding to products or structures are now on file. This library, located at the Ohio State University, Columbus, Ohio, wishes to make its collection of patents the



AS CHIEF ENGINEER, VALVE FAILURES ARE MY BUSINESS

. . . I've found Dexter is good Business!

We can't shut down power plants and cut off our steam, air, oil and water lines when production schedules are crowded as they are now. And we don't have a whole crew available to take out and replace leaky valves . . . even if we could get replacements.

So we put in a Dexter Valve Reseating outfit, and now one man can reseat a valve, right on the line in a few minutes.

At our plant the wheels must keep turning and we've found that the Dexter Valve Reseating outfit can help make that possible.

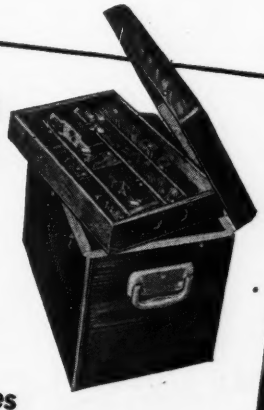
23

Delivery in 60 Days! Our non-military manufacturing facilities are catching up with our back orders, and we are now able to promise delivery in 60 days.

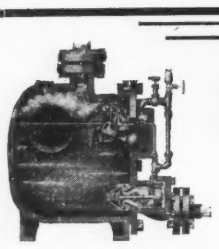
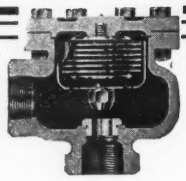
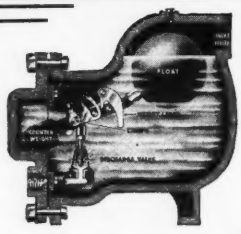
WE'LL ANSWER PROMPTLY

your inquiries about valve problems. Tell us your toughest valve-leak story. Please include full data.

DEXTER VALVE RESEATING MACHINES AND CUTTERS for Globe, Gate and Pump Valves



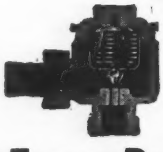
THE LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS

Specify

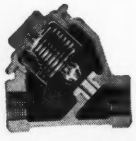
NICHOLSON

Performance-Proved

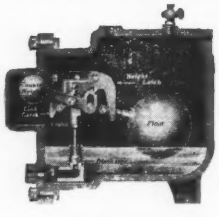


TRAPS

FOR



Every Power and Process Purpose



Featuring exclusive designs that assure enormous discharging capacity and faster, positive action, Nicholson makes: Weight-Operated, Piston-Operated, and Thermostatic Steam Traps; Compressed Air, and Gasoline Traps; Special Traps. For all pressures.

Catalog 444 or See Sweet's

W. H. NICHOLSON & CO.

160 OREGON ST., WILKES-BARRE, PA.

SYNTRON

"Pulsating Magnet"

ELECTRIC VIBRATORS

MAKE STUBBORN, WET COAL FLOW FREELY THRU BINS, BUNKERS & CHUTES

3600 powerful "Electronic-Controlled" vibrations per minute, break down arching and plugging—without damage to prime equipment.

Eliminate pounding and sledging.

Write for illustrated folder.

SYNTRON COMPANY 494 Lexington Ave., Homer City, Pa.

most complete in the world, and to accomplish this end, friends of the library are requested to send to the librarian the patent numbers on any patents pertaining to welding, welded equipment, welded machine design, welded structural design or any welding application. Authors and publishers are also requested to send copies of all their books and papers on welding subjects to the library for permanent filing and for use by industry in future years.

Printed copies of Simplified Practice Recommendation R207-45, Pipes, Ducts, and Fittings for Warm Air Heating and Air Conditioning, are now available and may be obtained from the Superintendents of Documents, Government Printing Office, Washington 25, D. C., for 10 cents each.

Elton Sterrett has been appointed executive secretary for the National Association of Corrosion Engineers, with offices at 318 Southern Standard Bldg., Houston, Texas. For the past 5 yr Sterrett was on the editorial staff of The Oil Weekly, Houston, and for 9 yr prior to that was assistant chief engineer for the Arkansas Pipeline Corp. at Longview, Texas.

Division of Simplified Practice of the National Bureau of Standards has announced that the proposed simplified practice recommendation for cast brass solder-joint fittings has been approved for promulgation. The recommendation is identified as R212-45, Cast Brass Solder-Joint Fittings, and became effective from July 1, 1945. The recommendation sets up a stock list of cast brass solder-joint fittings representing the best thought of the industry, its distributors, and customers as to what constitutes desirable practice for the present and the postwar days to come. Sketches illustrate the 37 types of fittings, various sizes of which are included in the list. Until printed copies of R212-45 are available, mimeographed copies may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington 25, D. C.

E. G. Bailey, a vice president of The Babcock and Wilcox Co., has been elected an honorary member of The Institution of Mechanical Engineers in England. Mr. Bailey is the fifth American to receive the honor.

The Baldwin Locomotive Works will open a headquarters in Paris, France, in September to provide coverage for Baldwin's heavy machinery in France and its colonies, Belgium, and Holland. Thomas Butts, native of Whitehall, Pa., was named to direct the new office. Mr. Butts has distinguished himself as a business specialist in American Embassies at Paris, Berlin and Brussels and more recently in vital war production activities with the U. S. Government.

The Bird-Archer Co. announces the retirement of R. B. Zane, Kalamazoo, as sales engineer for the Michigan and Northern Indiana territory. Bird-Archer chemical engineering services will be carried on in this area by Sylven E. Lawson of Detroit under the direction of Edward A. Lowenthal, western manager, Chicago office.

TROUBLED with Dezincification or Tube Erosion?

CONSECO

AIR and EROSION ELIMINATOR

- *Prevents electrolysis*
- *Resists dezincification*
- *Stops air erosion*
- *Triples life of tubes*
- *Proven successful in service*

Air in circulating water is conceded to be the chief cause of tube end deterioration. Before the development of the Conseco Air and Erosion Eliminator, no effective means of removing air from circulating water was available.

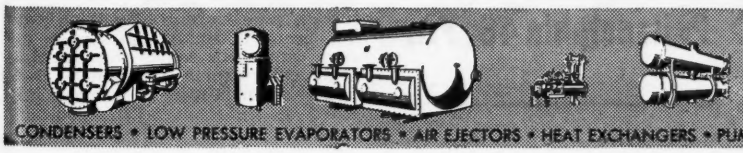
The Conseco Air and Erosion Eliminator consists of a special frame containing perforated plates (deaeration screens) of special metal, built into the water box facing the tube sheet. It stops electrolysis and dezincification. Gases in circulating water passing through plates are liberated and discharged through a manifold. Liberated gases attack perforated plates which are easily replaceable, instead of tubes and sheets. Tube life is increased at least three times normal, based upon over 20 years of successful service.

Send for full details.

SERVICE *A highly skilled, specially equipped service organization, ready for immediate action anywhere on the continent, backed by engineering and manufacturing facilities producing over 3,000,000 sq. ft. of heat exchangers annually.*

CONDENSER SERVICE & ENGINEERING CO., INC.

71 RIVER ST., HOBOKEN, N. J. Phone HOboken 3-4425 After 6 P. M. or Sundays - HOboken 3-4428



CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS

QUIMBY PUMPS

SCREW
ROTEX
CENTRIFUGAL
CHEMICAL

√ LESS FRICTION
√ LESS WEAR
√ LESS MAINTENANCE
IT ALL ADDS UP TO . . .
Longer Life!

QUIMBY VERTICAL SCREW PUMP

QUIMBY PUMP COMPANY
INCORPORATED
Division of H. K. PORTER COMPANY, Inc.
PITTSBURGH, PENNSYLVANIA
FACTORIES:
PITTSBURGH, PA. NEWARK, N.J.

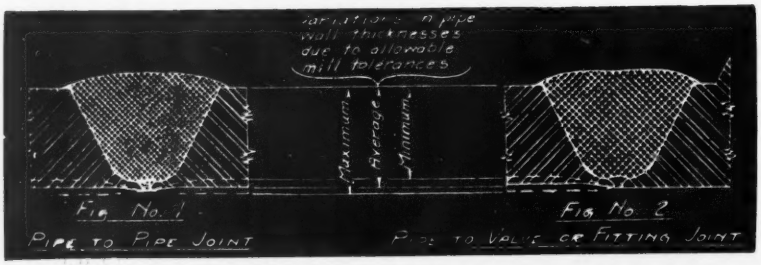
There's NO CONSTRICTION in pipe FLOW with this Welded Joint!

Why? Because with the Westport Patented Welded Joint, reduction in inside diameter at the root of the weld NEVER EXCEEDS the inside diameter of the pipe if furnished to the smallest internal diameter permitted under standard commercial tolerances!

You are assured the latest in power piping design . . . including the Westport Welded Joint . . . when you engage Mitchell & Company to handle your piping.

Specifically, the Westport Joint allows complete penetration to the root of the weld . . . smooth pipe contour at the base of the weld with no "icicles" or "protrusions" . . . no gaps between rings and the inside pipe wall . . . greater flexibility in alignment of pipe, valves and fittings.

It will pay you to write today for details and full information contained in the free bulletin we offer you. Write for it without delay.



Illustrated above is the Westport Method . . . consisting of the use of a joint in which the ends to be welded are formed and machined to provide a special U-shaped groove . . . joining the lips at the root of the weld by the oxyacetylene process . . . and completing the joint by the usual electric arc procedure. *Write for Bulletin and Full Details.*

W. K. MITCHELL & CO., INC. Philadelphia 46, PA.

1899 — M — 1944

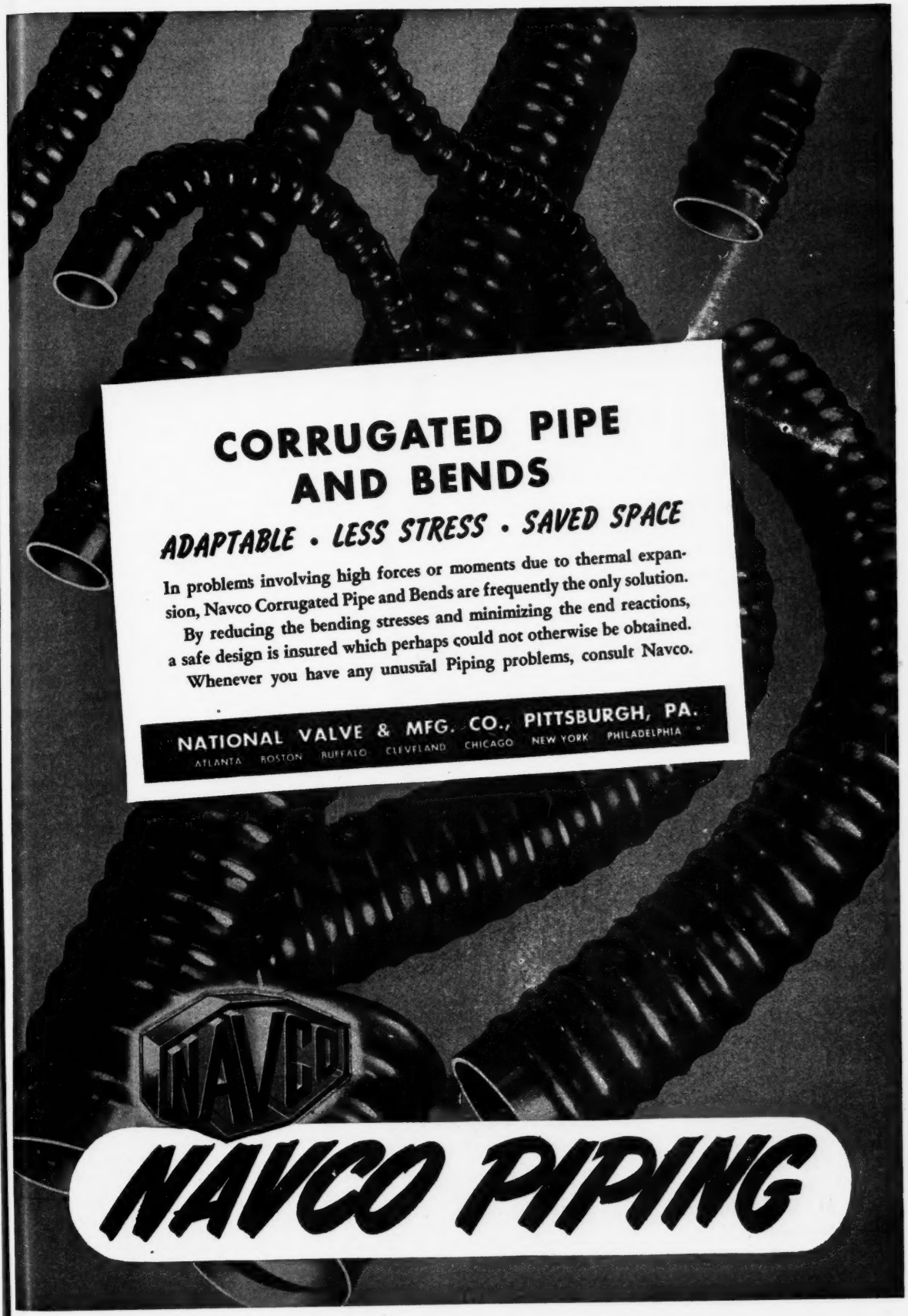
New ENGINEERING BOOKS

Power System Stability—Volume I, Steady State Stability, by Selden B. Crary. First Edition, 291 pages, 152 illustrations, size 5⅝ by 8⅝ in., cloth. Published by John John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1945. Price $4.00.

This book is the first of a two volume work intended to provide the fundamental theory necessary for an adequate understanding of the stability of power systems. Power system stability may be broadly defined as that property of a power system which insures that it will remain in operating equilibrium through normal and abnormal conditions. A study of the stability of a power system requires a knowledge of the operating characteristics of all its elements. Stability studies are usually made to determine the ability of the major elements to remain in synchronism during and following transient faults and circuit changes as well as during sustained load changes. These studies result in a determination of the degree of stability and an evaluation of the apparatus and system characteristics which effects stability. An understanding of system stability, therefore, requires a thorough knowledge of both steady state and transient performance.

When the principles of steady state and transient stability are correctly applied, an electric power engineer is able to determine the power limits of the major elements of a system especially during and following transient faults and load and circuit changes. He is able to specify the requisite apparatus and system characteristics and to judge accurately how they may be economically obtained to assure a continuous supply of electrical energy throughout the system. As is pointed out by the author, the technical literature on the subject of system stability is relatively large, and many valuable contributions have been made by engineers too numerous to mention. The art has advanced, however, to the point where it has become desirable to summarize and integrate some of the fundamental theories and important applications which have played a part in the development of the present concept of power system stability. It was with this object in view that the work of preparing this textbook was undertaken.

The first five chapters of Volume I develop the fundamental theory. The remaining seven chapters apply the theory of steady state stability to specific problems occurring most frequently in practice. The broad scope of material includes a clear discussion of such important subjects as power flow, power limits, stability criteria, composite systems, synchronous machines, power transmission, turbine generators, transmission loading, economic study and system design. Numerous charts and diagrams graphically explain the reading matter. Nomenclature is conveniently listed at the front of the book for ready reference. Volume II, in prep-


CORRUGATED PIPE
AND BENDS
ADAPTABLE • LESS STRESS • SAVED SPACE
In problems involving high forces or moments due to thermal expansion, Navco Corrugated Pipe and Bends are frequently the only solution.
By reducing the bending stresses and minimizing the end reactions, a safe design is insured which perhaps could not otherwise be obtained.
Whenever you have any unusual Piping problems, consult Navco.
NATIONAL VALVE & MFG. CO., PITTSBURGH, PA.
ATLANTA BOSTON BUFFALO CLEVELAND CHICAGO NEW YORK PHILADELPHIA
NAVCO
NAVCO PIPING

These Gauge Glasses are sturdy enough to give you long-lasting service where pressures are not excessively high. Crystal clearness makes reading easy throughout a long service life. Machine drawn accuracy of CORNING Standard Gauge Glasses makes installation simple without manipulation and without the installation strains that tend to shorten the life of gauge glasses.

A complete line to solve your particular gauge glass needs.

For high pressure duty or for locations where visibility is poor select the proper PYREX Gauge Glass for those service conditions from the complete PYREX Line. There is an economical, serviceable PYREX or CORNING Gauge Glass to meet your specific needs.

"PYREX" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, New York.

CORNING Glass Works Corning, New York

Corning Gauge Glasses

ALLPAX

THE PACKING THAT "PACKS ALL"

. . . use it once and
. . . you'll use it always

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

THE ALLPAX CO., INC.
Mamaroneck, N. Y.

Distributors Everywhere

aration, will provide the essential theory and applications underlying transient stability and its relation to system design. These two volumes will be found unusually helpful as authoritative source and reference books, both for electric power and design engineering students.

Controllers for Electric Motors, by Henry Duvall James and Louis Edwin Markle. First Edition, 324 pages, 336 illustrations, size 6 by 9, cloth. Published by the McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y., 1945. Price $3.50.

The object of this book is to bring together in one volume sufficient material on controllers to give technical students, operating engineers and purchasers and users of electrical apparatus a good general idea of their design and operation.

It is a manual on all types of commercial motor controls, describing their construction, performance and operation and giving pointers on maintenance for operating men application engineers and purchasers of control. In a simple treatment, readily understandable to anyone having only limited knowledge of motors, the book is a wealth of practical information on the safe and efficient control of motors including helpful explanations and diagrams on electronic tube control, arc rupturing, operation of Amplidyne, Rotrotrol and Regulex time delay methods of accelerating motors, protection of synchronous motors, obtaining regeneration with d-c motors, overload protection, etc.

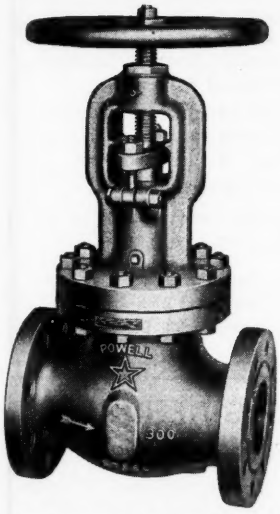
The types and methods of control described are illustrative of those in general use. No attempt has been made to represent all types of commercial equipment. Special control systems such as those applied to elevators, steel mills and paper mills have not been included since a detailed knowledge of the performance problem is necessary for an understanding of them.

The book contains some elementary chapters for the benefit of readers who have had little practical experience with control equipment. Most of the diagrams are of an elementary nature. When it is necessary to repair or adjust a controller the diagram and instruction should be obtained from its maker.

A good idea of the contents of this book may be gained from a list of the chapter headings as follows: 1, Function and Type of Control; 2, How to Read Controller Diagrams; 3, How to Make Controller Diagrams; 4, Magnetic Contactors; 5, Starting Characteristics of Motors with Different Methods of Control; 6, Methods of Accelerating Motors: 7, Methods of Speed Control; 8, Control for Special Applications; 9, Mechanical and Dynamic Breaking; 10, Regeneration; 11, Voltage Control for Direct Current Motors; 12, Series Parallel Control and the Electro Pneumatic Contractor System of Control; 13, Adjustable Speed Alternating Current Motors of the Wound Rotor Type; 14, Types of Resistors; 15, Manual Controllers; 16, Direct Current Magnetic Contactor Controllers; 17, Alternating Current Controllers; 18, Synchronous Motor Control; 19, Electron Tube Control; 20, Protective Devices; 21, National Codes Installation and Maintenance; 22, Future Control Development.

PURE NICKEL
MONEL METAL*
INCONEL*
VALVES

The Solution to many a flow control problem



Class 300-pound Cast Steel Gate Valve with Monel Metal trim.

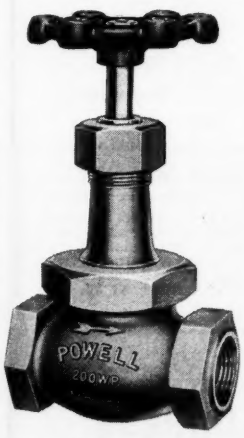
All-Pure-Nickel, all-Monel-Metal and all-Inconel Valves as well as valves with Monel Metal trim (internal working parts) are another outstanding Powell contribution to help solve Industry's flow control problems. In all services where corrosion and excessive heat or cold are encountered; where absolute purity of the end product must be maintained; and for the handling of steam, water, acid, alkalies and many other media these valves are superior to all others. This has been conclusively proved by performance records in leading plants throughout the nation.

For twenty years, Powell Engineers and the Powell Special Alloy Valve Division have designed and fabricated valves in a wide variety of pure metals and special alloys to meet every flow control requirement of Modern Power, Chemical, Food Processing and Textile Plants, Oil Refineries, etc. This specialization is your assurance of satisfaction. Write NOW for details and your copy of our new booklet "Powell Valves for Corrosion Resistance."

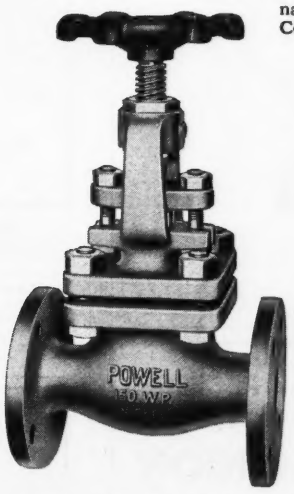
The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCK IN PRINCIPAL CITIES

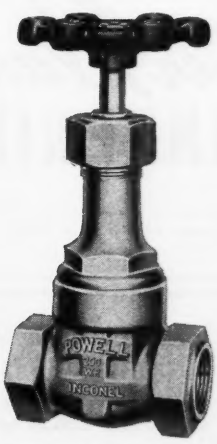
*These names are registered trade-names of the International Nickel Company, Incorporated.



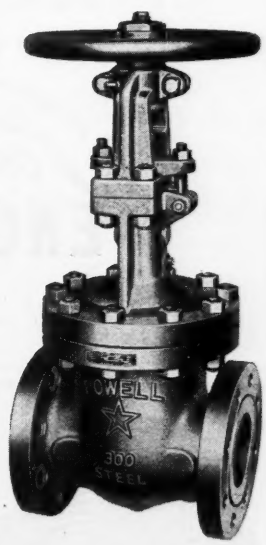
200-pound Globe Valve. Available in All Pure Nickel, All Monel Metal or All Inconel.



150-pound O. S. & Y. Gate Valve. Available in All Pure Nickel, All Monel Metal or All Inconel.

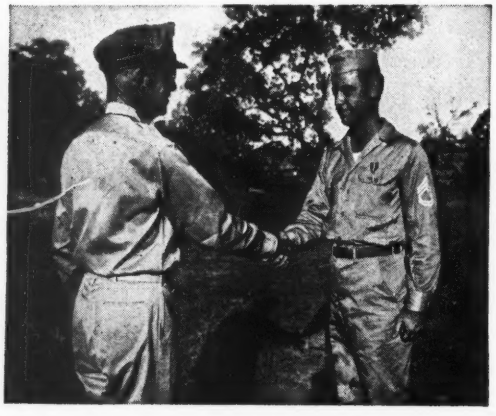


200-pound Gate Valve. Available in All Pure Nickel, All Monel Metal or All Inconel.



Class 300-pound Cast Steel Globe Valve with Monel Metal trim.

POWELL VALVES



The Pace of Victory Permits Only A Congratulatory Handshake

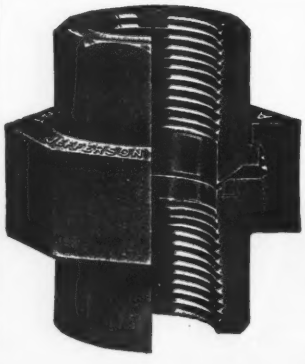
American Industry well merits a decoration for its brilliant record in the Mighty 7th! But, as our newly decorated Pacific heroes quickly return to combat, so industrial leaders aren't resting on their laurels. ***Back into Bond action*** —they are now busy consolidating recent Payroll Savings Plan gains!

Help to curb inflationary pressures and harvest peacetime prosperity by holding the number of Payroll Savings Plan subscribers—and amounts of individual subscriptions—to the mark set in the Mighty 7th!

The Treasury Department acknowledges with appreciation the publication of this message by

Power Plant ENGINEERING

This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council



The Feature of the RECESSED BRASS SEAT in the

JEFFERSON UNION

makes it unique

It is cut from seamless drawn tubing—free from all casting defects—sound and uniform always! It cannot be dislodged by a pipe end screwed in too far.

JEFFERSON UNION CO.

601 West 26th St., New York 1, N. Y.

Factories at Lexington 73, Mass., and Lockport, N. Y.

CLASSIFIED ADVERTISING

HELP WANTED

POWER ENGINEERS

Mechanical Engineers or Electrical Engineers, with aptitude and experience in heat balance thinking for work devoted to plant improvements, results engineering and effecting economy in the generation and consumption of steam, electricity, compressed air, water and refrigeration. Several openings for qualified men at different locations in the United States.

Give full experience, education, age, present salary and salary expected. Enclose snapshot.

Post-war opportunity.

Applicants must be able to obtain Statement of Availability.

E. I. du Pont de Nemours & Co., Inc.
Personnel Division
Wilmington 98, Delaware

ENGINEERING DRAFTSMAN

Large, old established Chicago concern. Should be experienced in foundry layout and plant engineering work. Good future for applicant with right qualifications. Please give age, experience, references and salary desired.

Box 1484
Power Plant Engineering
53 W. Jackson Blvd. Chicago 4, Ill.

POSITION WANTED

POSITION WANTED: Have 15 years' experience in operating and assisting chief operator in small and medium power plants. Good references. Must have post-war future. Age 36. Address Box 1486, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

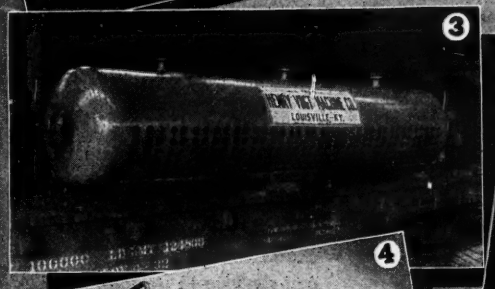
CHANGE OF ADDRESS

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

POWER PLANT ENGINEERING

A.P.I.—A.S.M.E. and A.S.M.E. CODES • CARBON STEEL AND SPECIAL STEEL

WELDED PRODUCTS by Vogt



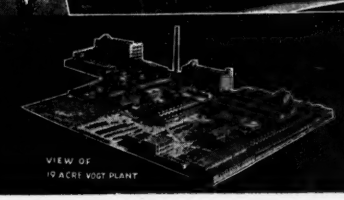
1 – 4′—0″ dia. x 7′—6″ dia. x 82′—5″ high Stabilizer Tower for a Texas Refinery. Fabricated to A.P.I.-A.S.M.E. Code, stress relieved and X-rayed. 250# working pressure.

2 – Heat Exchangers, for an Eastern Refinery, on the testing floor. Units have fusion welded Monel Metal shells and were built to customer's specifications.

3 – 48″ dia. x 22′—6″ long mud drum for a Vogt Water Tube Boiler designed to operate at 450# S.W.P. Fusion welded to A.S.M.E. Boiler Code.

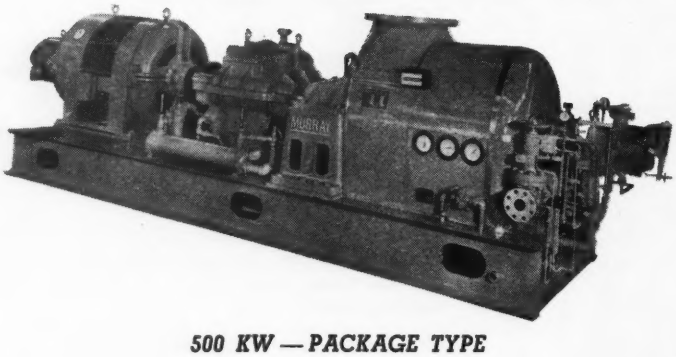
4 – Battery of Absorption Columns in a Western Refinery. Units are 33″ dia. x 41′—0″ high and were stress relieved after welding.

5 – 400 KV Industrial X-ray unit in our plate welding department. Exographs of welded seams can be quickly made because of the special motor operated rolls and traveling carriages which are adjustable to vessels of any size.


VIEW OF 19 ACRE VOGT PLANT

HENRY VOGT MACHINE CO.
Incorporated
LOUISVILLE, KENTUCKY
BRANCH OFFICES: NEW YORK · PHILADELPHIA · CLEVELAND · CHICAGO · DALLAS

MURRAY
TURBINE-GENERATORS



500 KW — PACKAGE TYPE

The unit shown was designed to deliver 500 KW alternating current on steam at 285 lb Gauge initial pressure, 700 degrees F. total temperature and 27 inches vacuum. Provided with a rigid structural steel baseplate, and with all service connections except generator leads above the floor line, the machine can be handled as a unit and installed with a minimum of preparation.

While "Package Type" units were furnished for export for installation in remote areas not previously supplied with power, the design can be utilized for small industrial plants for main or standby power supply.

MURRAY also produces

Mechanical Drive Turbines—Horizontal and Vertical
Reduction Gears
Steam Boilers

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 740 REIBOLD BLDG., DAYTON, OHIO

New, Low-Cost Method of combating

Slime in Humidifying Installations

The Oakite Scientific Staff has been successful in formulating a material to solve another worrisome problem—that of combating formation of slime and mold in humidifying equipment.

This newly-developed material, Oakite Composition No. 52, in addition to controlling slime accumulations, also possesses potent lime-solubilizing properties that help prevent scale build-up and attendant clogging of atomizers, drains and return lines. Systems can continue to perform at peak efficiency . . . equipment maintenance time is reduced.

Solutions of Oakite Composition No. 52 are odorless, non-toxic and may be sprayed into the plant atmosphere while the plant is operating. Complete data describing this new water conditioner gladly sent on request—no obligation, of course.

OAKITE PRODUCTS, INC.
18C Thames St., New York 6, N.Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE *Specialized cleaning*
Buy Bonds for Victory
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

PLAN TODAY

TO MOVE COAL

THE G-W WAY

A Three-Point Way to Better Coal Handling

There are three main factors in planning coal handling systems — *speed . . . space . . . cost.*

Time consumed in conveying coal from *point of receipt,* to *point of storage,* to *point of use,* demands careful consideration to determine the fastest method. Space to be occupied for storage should be conserved to the minimum required for continuous, active supply and ample reserve stockpile. Initial, maintenance, and operation costs are determined by soundness of design, dependability of materials, and quality of workmanship.

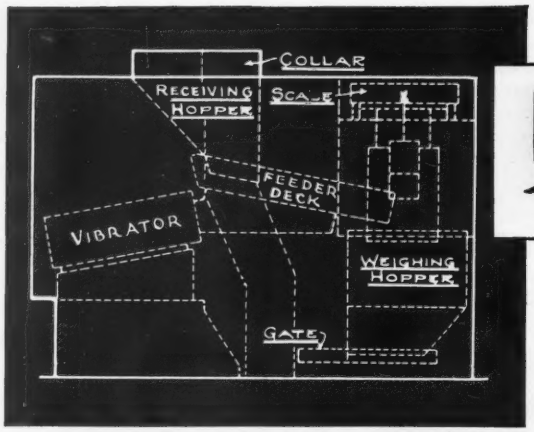
Gifford-Wood takes all three factors into consideration when adapting conveyors, carriers, skip hoists and elevators to specific installations. Where standard G-W equipment does not fit requirements, complete new equipment and arrangements are designed, built and installed . . . all to the traditional G-W reputation for ruggedness, long service and high quality materials . . . earned through more than 130 years' experience in serving the handling requirements of nearly every industry. When you revise your method of moving coal in — and moving ashes out — plan to do it "The G-W Way". Gifford-Wood Co., 420 Lexington Avenue, New York 17, N. Y.; 565 West Washington Street, Chicago 6, Ill. Factory — Hudson, N. Y.

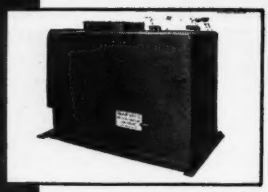
DO YOU KNOW? G-W maintains the complete facilities of a well-organized, manufacturing plant . . . pattern shop, machine shop, steel, forge, paint and inspection shops . . . fully equipped with modern machinery for handling all general contract work.

G-W HANDLES IT
Faster · Easier · Cheaper

GIFFORD-WOOD
SINCE 1814

151





Pat. applied for.

Features:

- No rotating parts
- High weighing accuracy
- Dustproof cabinet
- Quiet operation
- Long life
- Handles wet material

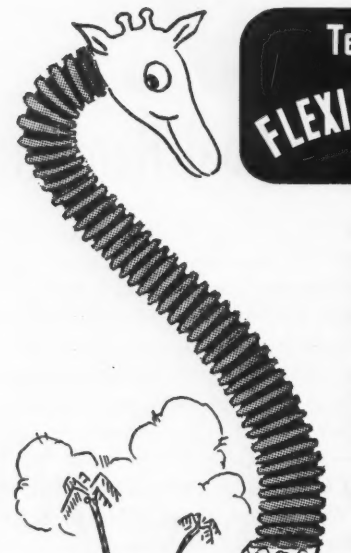
WET COAL can't stick to the Beaumont "Vibro" Automatic Weighing Scale Feeder.

No rotating parts in the Beaumont Scale to which wet coal can stick. Simplified design ensures accurate—automatic—weighing of coal, and similar materials. Feeder capacity adjustable. Units made for feeding materials at from 1 to 60 tons per hour. Request descriptive bulletin.

BEAUMONT BIRCH COMPANY

1503 RACE STREET PHILADELPHIA 2, PA.

DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS



Tell us about your FLEXIBLE PIPING PROBLEMS

Our engineers will be glad to put at your disposal their experience in helping answer hundreds of tough problems on handling of oils, chemicals, refrigerants, gases, air, steam, and other fluids where expansion and vibration are present.

The marked ability of ECLIPSE Seamless Metal Hose to withstand punishing heat and jarring comes from its deep parallel sidewall corrugations which combine *maximum flexibility* with *long working life.* Steel Hose can be produced up to 40 in. I. D. Metal Hose is made in two degrees of pitch, normal and close.

New Bulletin H-201 contains helpful handbook data on metal hose applications — ask for free copy.

THE INVISIBLE CREW Bendix AVIATION CORPORATION

Dept. 19—Phila. Div.—Philadelphia, Pa.

ECLIPSE *Seamless* METAL HOSE

CHANGE *of Management* AT FRANCE PACKING

E. A. France, son of Adam Warren France, who patented France Metallic Packing and founded the business nearly fifty years ago, is now president and general manager. J. C. Allen is the new treasurer. Both Mr. France and Mr. Allen have been active in the manufacture of metallic packing for many years.

The new management pledges that it will produce the same high quality metallic packing that has been operated so successfully in engines, pumps and compressors under all conditions of service for nearly half a century. Furthermore, every effort will be made to reorganize the business in order to improve service and delivery.

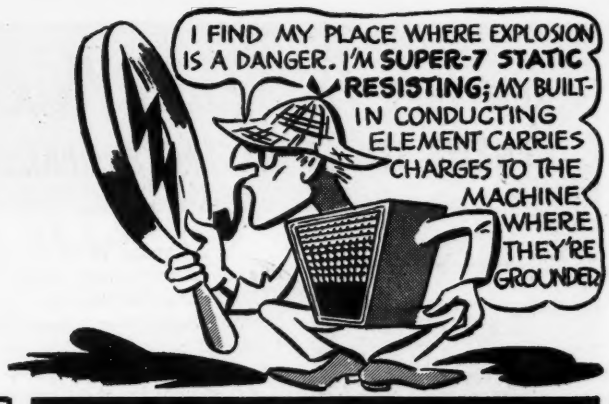
Remember the Name, FRANCE, Standard of the Industry.

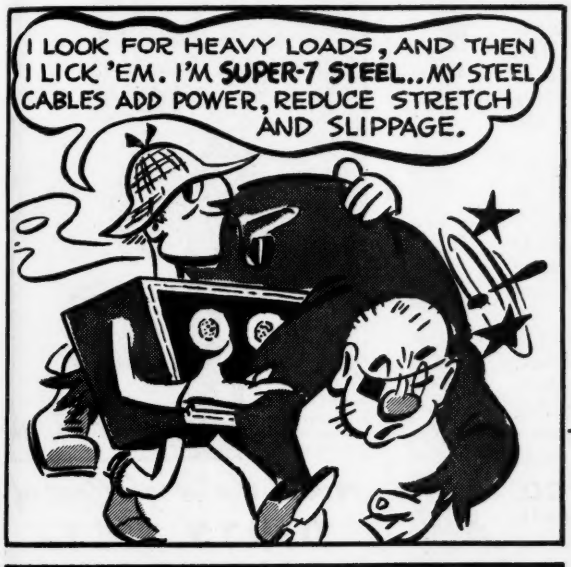
FRANCE PACKING COMPANY

PHILADELPHIA 35, PA.

LOOKING for TROUBLE!

Designed to stand up in trouble spots, America's newest and widest line of V-belts — Allis-Chalmers' Texrope — solves every one of these drive problems


I FIND MY PLACE WHERE EXPLOSION IS A DANGER. I'M SUPER-7 STATIC RESISTING; MY BUILT-IN CONDUCTING ELEMENT CARRIES CHARGES TO THE MACHINE WHERE THEY'RE GROUNDED



IT PAYS TO MAKE **ALLIS-CHALMERS** YOUR

V-BELT DRIVE HEADQUARTERS

Texrope Super-7 V-Belts result from the cooperative research of two great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by A-C.

Typical of the complete line of money-saving CHESTERTON Mechanical Packings is Combination Style 75 recommended on hydraulic pressure to 800 lb. for outside-packed plunger pumps.

As shown by the cross-section view, Combination is a square flax packing made *sectionally*. This construction readily responds to gland pressure; thus the packing continually renews itself as the surface wears.

Distributors of CHESTERTON Mechanical Packing—located in all principal cities—are qualified by training and experience to study your hydraulic and other pressure seal problems; suggest how to simplify maintenance.

Ask for new 72-page CHESTERTON Catalog and Handbook. Contains packing-selector chart, conversion tables for cutting ring packings and other useful engineering data. For your free copy write:

A. W. CHESTERTON CO.
64 INDIA ST. BOSTON, MASS.

TEMPLETON RETURN STEAM TRAPS
for Pumping, Boiler Feeding, Draining, Heating and Vacuum Lines

- Pumps Water at any temperature or pressure.
- Open float cannot burst or waterlog.
- Valves and Seat Bronze or Stainless Steel.
- Sizes 1 in. to 4 in. inlet and outlet.
- Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.

Ask for catalogue and prices

TEMPLETON BROS., INC.
699 Main St. Walpole, Mass.

Fig. 118 All-Service Separator

Above: Vertical Separator protecting Steam Engine.

Right: Horizontal Separator removing oil from exhaust steam.

Avoid the High Cost of

DIRTY, WET, OILY STEAM

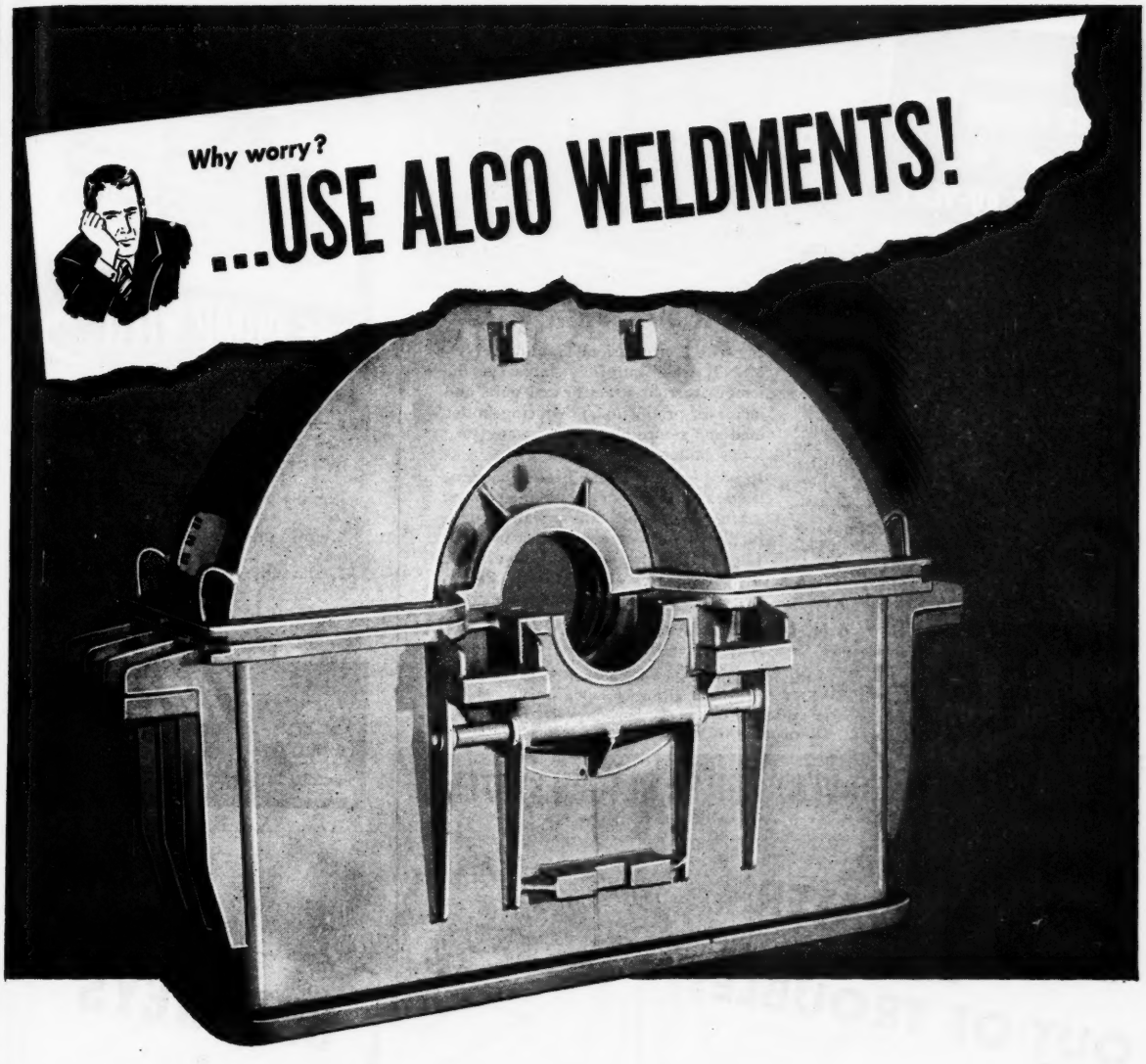
Keep It Clean and Dry with

COCHRANE
ALL-SERVICE
SEPARATORS

You can completely remove moisture and solid entrainment from dirty, oily, wet steam, air and gases by installing Cochrane Separators. Complete purification is assured, due to exclusive design of baffles and ports which produce a direct, unrestricted fall of entrainment, prevent the purified steam from passing over the drip area, and minimize pressure loss by means of extra large port areas.

Write for details.

COCHRANE CORPORATION
A DIVISION OF AMERICAN ENGINEERING COMPANY
3123 N. 17th St., Philadelphia 32, Pa.



Here's Why: Weldments are becoming increasingly popular as a superior, more economical method of fabricating metal parts and products.

Of course. For one thing, rejects do not occur with weldments after machining starts. That means weldments *save worry and waste.*

For this reason, and other reasons stated below, weldments often *cost* less than any alternative available for the same service.

Another important angle is that there is a large body of skilled welders. Hence, schedules are less likely to be interrupted because of possible skilled-labor shortage.

ALCO guarantees to furnish engineering talent to design your product or part for production by ALCO weldments, and to produce such weldments as will ensure the following:

1. Complete machining without rejects due to faulty materials.
2. Prompt delivery.
3. Higher-quality product.
4. Less weight.

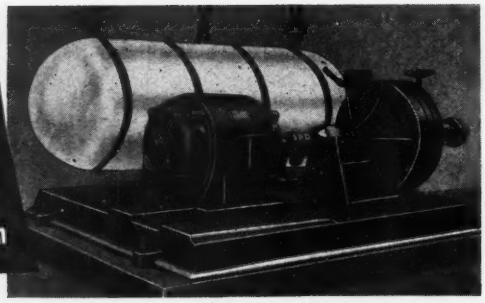
And remember, no item is too complicated for ALCO weldment design.

American Locomotive

ALCO PRODUCTS DIVISION

30 Church Street, New York 8, N. Y.
Dunkirk, N. Y.

Increase YOUR PRODUCTION with the STOUT NO-VENT Boiler Return System



—for Cookers, Heaters, Driers, etc.

It operates continuously returning condensate, ALL OF IT, fast as formed and at the same pressure and temperature at which it leaves the steam heated units. Air and non-condensibles are then automatically removed and the condensate, in the form of distilled water, returned direct to boiler. There are no traps or orifices in the system.

High temperature direct return saves fuel. Often 25% or more. (This would offset the 20% cut expected in soft coal deliveries to industry as announced July 14th by Secretary Ickes.)

Improved circulation the Stout NO-VENT way uniformly increases the temperature in steam heated units and increases production. Reducing boiler load and returning distilled water prolongs boiler life.

If you operate steam heated cookers, heaters, driers, ironers, clothing presses, drying ovens, oil tanks, water tanks, pickling tanks or have other uses for so-called "process steam" investigate the Stout NO-VENT Boiler Return System. It can boost your production.

DAVID STOUT & SONS • 6 N. Michigan Ave. • CHICAGO 2, ILL.

Heat Reclaimers • Steam Condensers • Spiro Water Heaters • Gas Fired Boilers

Write for bulletin showing hookup of Stout NO-VENT System and giving operating details. Made in capacities 100 to 800 bhp, pressures to 200 lb. Distributors will be interested in selling franchise.

Stout NO-VENT BOILER RETURN SYSTEM

IMO

THE PUMP WITH

what it takes to combine a maximum of capacity, pressure and reliability with a minimum of space, weight and power consumption. That's why so many thousands of IMOs are used.

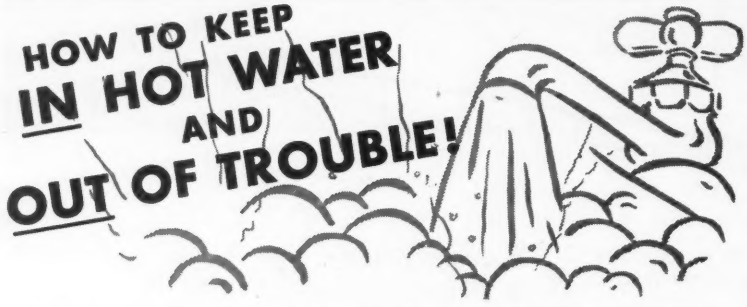
For information send for Catalog I-121-C

IMO

PUMP DIVISION OF THE DE LAVAL STEAM TURBINE CO.

TRENTON 2, NEW JERSEY

HOW TO KEEP IN HOT WATER AND OUT OF TROUBLE!



• Where it's essential to keep a steady supply of hot water, install the MARION GULF STREAM HOT WATER HEATER. Indispensable to hotels, office and apartment buildings, large institutions, and factories of all kinds where abundant hot water is essential and steam is available.

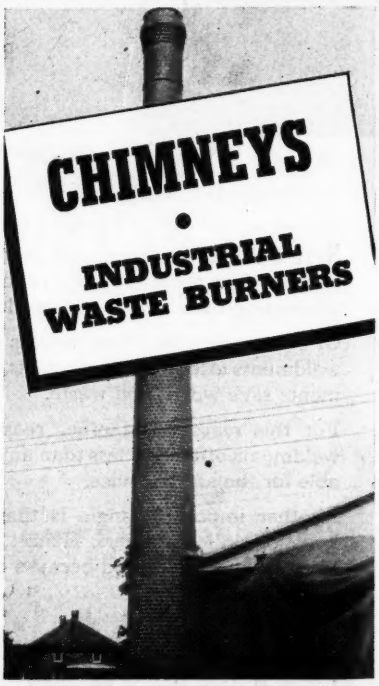
Construction is simple. Water is heated faster through intimate contact with steam chambers adjoining. Internal parts float independently, avoiding strain from rapid contraction and expansion.

Low pressure steam is utilized with greatest economy. Inexpensive investment. Capacities range from 370 to 3700 GPH. Instantaneous type but can be used with storage tank.

Write Us Your Requirements and Let Us Solve Your Hot Water Problem!

THE MARION LINE

MARION MACHINE, FOUNDRY & SUPPLY CO.
Marion, Indiana, U. S. A.



AMERICAN CHIMNEY CORP.
143 Fourth Ave., New York 3, N. Y.
BRANCHES: BOSTON • PHILADELPHIA
CLEVELAND • DETROIT

POSITIVE LEAKPROOF *Remote Control*

Official U. S. Navy Photograph

● Maximum flexibility of control is provided by Grove Flexflo Valves in the operation of large and smaller Diesel Engines. On Diesel starting, air is normally supplied instantly upon demand, but the Flexflo Valve is readily adjustable for retarded-opening in accordance with existing requirements. Being fully self-operating and utilizing *NO METALLIC* moving parts. This Expansible tube type valve delivers smooth, non-turbulent flow at capacities greatly in excess of conventional globe and other types of valves. Positive bubble-tight shut-off precludes the loss of air, fluids or gas. Remote operation is effected by any standard medium. Investigate fully, today.

★ *ELECTRIC*

★ *DIRECT PNEUMATIC*

★ *INDIRECT HYDRA-PNEUMATIC*

★ *INDIRECT HYDRAULIC*

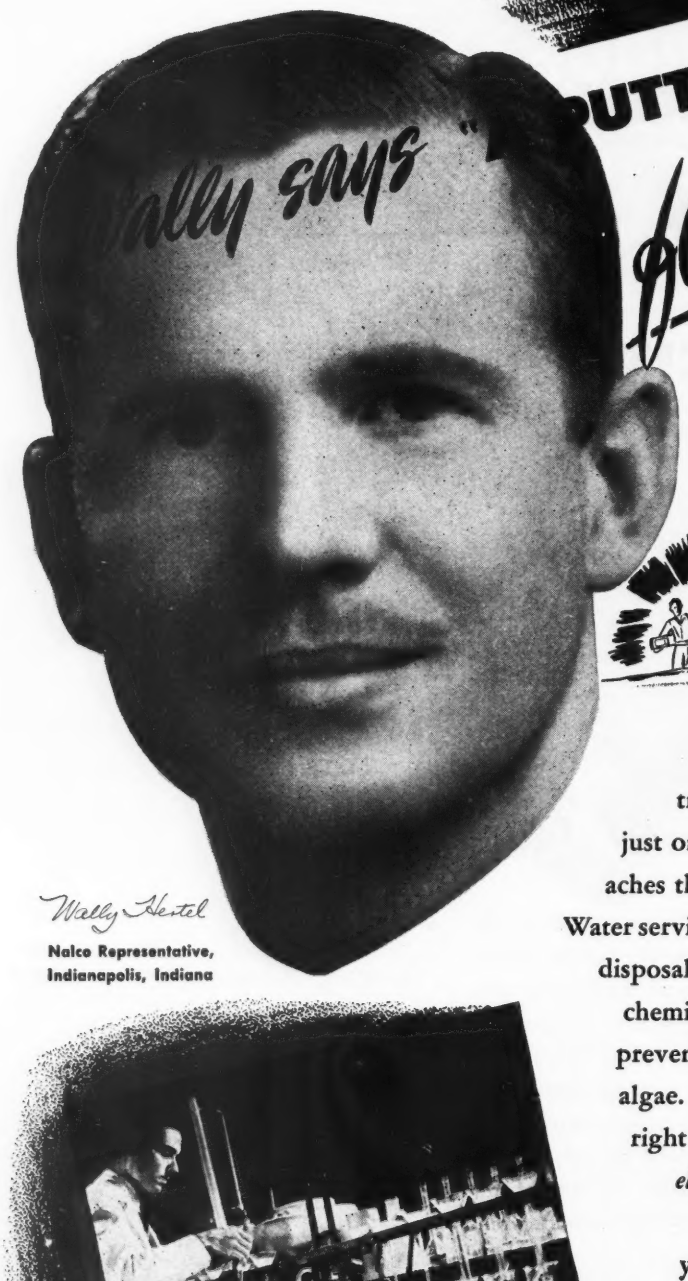
Although primarily employed for air-starting service Grove Flexflo Valves readily adapt themselves to many other Diesel applications such as in the Remote Control of: Cooling Water; Auxiliary Lubricating Oil; Fuel Oil; Gas; Gasoline, etc. For full details

WRITE FOR
DIESEL BULLETIN *#810 TODAY*

GROVE *Flexflo* DIESEL VALVE

GROVE REGULATOR COMPANY

6491 GREEN STREET, OAKLAND 8, CALIFORNIA • *Branch Offices:* 30 Rockefeller Plaza, New York 20 • 5644 Navigation Boulevard, Houston 11, Texas • 1930 West Olympic Boulevard, Los Angeles 6, California



Wally Hestel

Nalco Representative,
Indianapolis, Indiana

UTTER IS OK

for putting

. . . but it takes a complete set of clubs to play the game right"

. . . and the same holds true when it comes to water treatment . . . it takes more than just one chemical to banish the headaches that accompany untreated water. Water service engineers should have at their disposal a wide range of water treating chemicals to choose from in order to prevent scale, corrosion, foaming and algae. . . . Nalco water treatment goes right to the heart of the trouble and *eliminates it once and for all!* It is an exact science. Let us show you what Nalco can do for you. Ask for a Nalco survey today.

THE SYSTEM OF SCIENTIFIC WATER TREATMENT FOR ALL INDUSTRY

Nalco

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Ave., Toronto, Ontario

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 **Compact Steam Generators**—New folder describes the Steam-Pak high and low pressure boilers for use with all fuel oils. Because boilers are light weight and require only a vent for combusion gases, they may be placed close to load. York-Shipley, Inc.

2 **Automatic Fuel Burner Lighting**—Bulletin OB-PC, 32 pg, describes application and operation of an automatic system to light oil fuel burners and retract the ignition system out of the hot zone by remote control. For pulverized coal, oil or gas. The Enginier Co.

3 **Steam Generating Equipment**—Attractively illustrated new bulletin describes design and application of Edge Moor vertical flow bent tube boiler, radiant heat boiler, waste heat boiler and other units. Sectional views show arrangement, for firing various fuels. Edge Moor Iron Works, Inc.

4 **Boiler Tube Care**—Card gives important information regarding care and maintenance of boiler tubes. Steel & Tubes Div. Republic Steel Corp.

5 **Refractory Coating**—Folder describes Saverite, applied with brush to bind old cracks and loosened brickwork, and to prolong life of wornout refractories. Saverite Engineering Co.

6 **Portable Firebox Boilers**—A new bulletin, describing their re-designed portable two-pass type firebox boilers has been issued by the Titusville Iron Works Co. These boilers are adaptable to any fuel; have new type self-cleaning crown sheet; liberally braced in excess of all codes. Available in standard sizes having coal hand fired ratings of 25 hp to 250 hp, and mechanically fired ratings of 30 hp to 304 hp, for pressures of 100 lb., 125 lb. and 150 lb.

7 **Heat Exchanger Data**—Bulletin No. H-1 tells about Brownell generators for heating water with live steam under pressure of 100 lb.; also exhaust type heat exchanger. Gives tank and coil specifications, horsepower ratings and other useful data. The Brownell Co.

ELECTRICAL

8 **Gearmotor Applications**—Booklet B-32-18 describes gearmotors and illustrates practical applications. Gearmotors are standardized for easy application and postwar conversion. Westinghouse Electric Corp.

9 **Power Transformers**—20-page Bulletin No. S-402 discusses modern trends, core and coil elements, ratings, dimensions, weights, specialized designs, standard parts, accessories and applications of power transformers. Standard Transformer Co.

10 **Motor Lubrication Sheet**—Reliance Electric & Engineering Co, announces the publication of an instruction sheet, No. 3042, covering the grease lubrication of anti-friction bearings in Reliance a-c and d-c motors, v-s drives and m-g sets. Details construction, maintenance and lubrication recommendations for double-shielded ball, open ball, and spherical roller bearing types as installed on Reliance equipment.

11 **Arc Welding Ideas**—20 pg booklet, entitled "101 Welding Ideas for Low-Cost Maintenance," points out profitable applications of Shield-Arc welding in a wide variety of industries. Lincoln Electric Co.

12 **New Condensed Motor Catalog**—Gives ratings, sizes, characteristics, dimensions, where-to-use data, and prices of G. E. a-c and d-c motors, 1/16 to 75 hp. This boiled down data simplifies motor selections. General Electric Co.

FANS, PUMPS, COMPRESSORS

13 **Steam-Jacketed Rotary Pumps**—Bulletin W-487-B11 gives specifications, sizes and other data on Worthington steam-jacketed rotary pumps. Widely used for handling chocolate, grease, molasses and other liquids requiring pre-heating. Worthington Pump & Mach. Corp.

14 **Fans And Blowers**—Buffalo Forge Co, Bulletins No. 3553, 3533 and 3499 discuss pressure blowers, centrifugal compressors, axial-flow fans and vent sets.

15 **Handbook On Centrifugal Pumps**—How to make pump casings last longer, how to check foundations and connections for misalignment and many other practical tips will be found in "Handbook for Wartime Care of Centrifugal Pumps." Contains no advertising, applies to all makes of pumps. Allis-Chalmers Mfg. Co.

16 **Freon Refrigeration Units**—Folder describes Worthington refrigeration units for use in air conditioning product and industrial refrigeration. Sizes from 1/4 to 100 hp using Freon-12 or methyl chloride. Small models available with air or water-cooled condensers. Worthington Pump and Mach. Corp.

17 **Facts About Centrifugal Pumps**—Many helpful suggestions on the selection of pumps to do certain jobs are contained in new handbook "Facts You Should Know about Centrifugal Pumps and Impellers." The Deming Co.

18 **Filtering Compressed Air**—Practical answers to problems of removing oil, water and pipe scale from compressed air system are described in new folder on Adams poro-stone air filters. Section view in 3 colors shows centrifugal separation. Dimensions and prices are listed. R.P. Adams Co., Inc.

19 **Time-Saving Compressor Calculator**—An ingenious compressor calculator, designed to save time in computing compressor requirements or in estimating the performance of present compressor units has been prepared by The Cooper-Bessemer Corp. Pocket size, of slide rule design; can be used for quickly estimating the volumetric efficiency, brake horsepower and total piston displacement of any make of compressor.

INSTRUMENTS AND CONTROLS

20 **Flow Rate Measurements**—Booklet "A New Era in Flow Rate Measurement" describes in semi-humorous style the wide flow range, constant pressure drop and other advantages of the Rotameter. Measures corrosive gases, liquids and slurries. Fischer & Porter Co.

21 **Process Control Terms**—Booklet by that title contains proposed A.S.M.E. definitions of automatic control, relay operated controller, drift and other terms. Also contains simple pictorial interpretations. A useful reference for those specifying or installing process control equipment. Askania Regulator Co.

22 **Whistles and Signals**—Leslie-Tyfon whistles and signals for air or steam service are pictured and described in 12-pg Leslie Bulletin No. 421. Contains dimensions, data on audibility range, frequency and installation tips. Leslie Co.

23 **Data On Flowmeter**—New 16-pg bulletin No. R-100A contains helpful data on selection of a Rotameter for any particular service. Bulletin also presents catalog material on the Cochrane line. Cochrane Corp.

24 **Engine Alarm System**—Data Sheets tells how Viking alarm systems guard against engine breakdown when circulating water temperature is too high or oil pressure is too low. Viking Instrument Co.

25 **Automatic Control of Industrial Processes**—Bulletin 45-713, entitled "Hays Instruments and Controllers in Industry," features schematic drawings of typical applications to the following industrial control problems: pressure reducing, pressure relief or back pressure, rate of flow, turbine-driven compressor control, and control of speed, liquid level and liquid density. The various instruments and controllers applicable to these problems are illustrated and described in detail. The Hays Corp.

26 **Machine Running-Time Recorder**—The Bristol Co. has published a folder, Bulletin No. OP1502, describing a newly developed machine running-time recorder. Folder gives information regarding principle of operation and method of use. Typical chart records are illustrated.

MAINTENANCE MATERIALS

27 **Packing Recommendation Charts**—Belmont's Packing Recommendation Charts provide handy tips for maintaining stuffing boxes in water, steam, oil and gasoline service. Also describe the complete line of Belmont packings. The Belmont Packing And Rubber Co.

28 **Improved Floor Cleaner**—Folder tells about Maintenex, a crystal cleaning powder for factories, dairies, department stores and other buildings with heavy traffic. Fluorescent color indicates correct dosage; dissolves in hot or cold water; emulsifies dirt rapidly. A. C. Horn Co.

29 **Rust Preventives**—4-pg bulletin, "The Service Factor," First Edition, 1945, covers new rust preventives and their applications. Sinclair Refining Co.

30 **Welding Alloys**—New 4-pg folder gives applications, uses and specifications on design and procedure of various low-temperature welding rods. Eutectic Welding Alloys Co.

30A **Cathodic Method of Rust Prevention**—How the Rustop electrochemical system prevents underwater corrosion in water tanks, standpipes, pressure tanks and many types of process equipment is described in new folder. May be installed without draining tank; uses ac or dc. Electro Rust-proofing Corp.

31 **Help In Selection Of Packings**—A new pocket size folder on Palmetto Packings serves as an unusually handy guide to selecting the most suitable packing for specific fluids, equipment, and types of service. Condensed descriptions of each grade of Palmetto Packing give the leading features and purposes, accompanied by identifying illustrations. The center pages of the folder are ingeniously arranged to combine a complete application chart of Palmetto Self-Lubricating Packings with marginal references to descriptions of each of these packings. Greene, Tweed & Co.

Coupon must be filled in completely to secure literature your request. Pasting coupon on penny postcard saves time and money.

AUGUST, 1945

POWER PLANT ENGINEERING
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph number:

.....
.....
.....

Your Company Name .....

Company Address .....

Your Name .....

Your Title .....

City ..... State .....

(If you prefer delivery at your home also fill in below)

Home Address .....

City ..... State .....

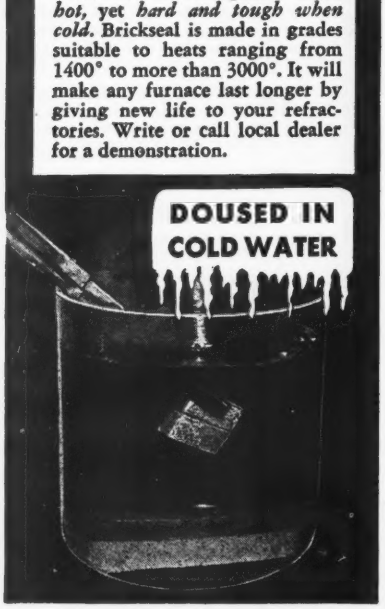
Demonstrating

BRICKSEAL

REFRACTORY COATING

Brickseal provides a crackproof, vitrified armor for furnace linings. The small firebricks shown in the furnace were bonded and painted with Brickseal and heated to 2250°. Directly from the furnace they were plunged into cold water as shown below—a test for *any* material subject to expansion and contraction.

Brickseal is *semi-plastic when hot,* yet *hard and tough when cold.* Brickseal is made in grades suitable to heats ranging from 1400° to more than 3000°. It will make any furnace last longer by giving new life to your refractories. Write or call local dealer for a demonstration.



BRICKSEAL

REFRACTORY COATING

Plants at

1031 Clinton St., HOBOKEN, N. J.

5800 S. Hoover St., LOS ANGELES 44, CAL.

32 **Leather Packings**—Attractively illustrated 64-pg bulletin discusses design and application of hydraulic and pneumatic leather packings. Chicago Belting Co.

33 **Cleaning Compound**—New 20-pg digest gives practical tips on techniques and materials for handling cleaning, degreasing, descaling, derusting, paint stripping and other power-plant maintenance tasks. Oakite Products, Inc.

PIPING, VALVES, FITTINGS

34 **Steam Trap Data**—Tables, charts, price list, how to figure sizes of these traps, and other interesting data will be found in a recently published bulletin—T-1739. Installation and operating suggestions are also given. Yarnall-Waring Co.

35 **Fluid Handling Equipment**—Catalog No. 45 give dimensional and technical information about a wide range of Zurn fluid handling equipment; covers duplex strainers, safety vents, interceptors for wax and grease, discharge check valves. J. A. Zurn Mfg. Co.

36 **Condenser Tube Protector**—New bulletin tells how John Crane condenser tube protectors stop tube thinning and erosion. Protectors are molded of wear-resistant thermo-setting plastic; unaffected by temperatures to 275 deg. F. Crane Packing Co.

37 **Automatic Control Valves**—New Catalog No. 26 describes design and operation of Golden-Anderson triple-acting non-return and other types of automatic control valves with equivalent pressures and other useful engineering data. Golden-Anderson Valve Specialty Co.

38 **Seamless Metal Hose**—Design and applications of Eclipse seamless flexible metal hose are covered in Bulletin H-201. Widely used for air, oil, steam, chemicals, exhaust and other lines subject to expansion or vibration. Bendix Aviation Corp.

39 **Steam Trap Handbook**—Tables, charts, diagrams and rules for selecting traps, giving complete explanations, make the new 36-pg Armstrong Steam Trap Book a handy reference volume for every engineer's library. Armstrong Machine Works.

40 **Pre-Engineered Spring Hangers**—Folder tells how Grinnell "packaged" spring hangers save engineering time on flexibility supported piping systems. 14 sizes available from stock; load range from 84 to 4700 lb. Grinnell Co., Inc.

41 **Air Hose Safety Valve**—New bulletin tells about the Aveco Limit-Flo safety valve that eliminates dangerous whipping action when high pressure air hose breaks or connection fails. Easily installed, no adjustments necessary. Associated Valve & Engineering Co.

PRIME MOVERS

42 **Story of the Diesel**—"The Story of the Diesel," a 36 pg booklet just published by the Diesel Engine Manufacturers Assn., discusses in concise, non-technical, easy to read style the Diesel's post-war future, its present fields of application, and advantages over other types of power. A chart depicts graphically the industry's enormous growth in horsepower-output from 1937 to 1944.

43 **Low-Speed Generators**—Bulletins No. PB2000E-1144 and PB2000ED-1144 explain construction features of Types E and ED low-speed a-c generators. Electric Power Dept, Elliott Co.

44 **Mechanical Drive Turbines**—Elliott mechanical drive turbines, type CY, with built-in reduction gearing, are discussed in Bulletin H-15. The single stage mechanical drive turbine with built-in reduction gear combines the standard Elliott CY turbine with a specially built vertically-offset gear. Elliott Co.

45 **Data On Engine Superchargers**—"Supercharging for Greater Power and Improved Performance" is a booklet showing advantages of positive displacement superchargers in all types of marine, industrial and automotive engines, either gasoline or diesel. Applied to internal combustion engines the supercharger assures higher overall volumetric efficiency by more uniform fuel combustion and the ability to burn more fuel when necessary for increased power. B-W Supercharger, Inc.

(Continued on page 178)

FOR ANALYTICAL *Control* OF CORROSION...

Taylor

LIQUITROL

THE MODERN METHOD TO CONTROL pH, CHLORINE AND PHOSPHATES

Today's expanded production demands call for a quick on-the-spot method to check and control corrosion, that ever present danger in boilers that can cause slow-ups and even plant shut-downs.

Taylor Liquitrol is the modern method that enables plant engineers to make accurate determinations of pH and chlorine in 60 seconds and phosphate in 2 minutes, ***in any part of the plant.*** No getting anything ready . . . no checking equipment . . . no assembling "extras."

Only the Taylor Liquitrol Method includes proved and practical Taylor Comparators, with the speedy 1-2-3 step determinations designed for specific industrial applications. Only Taylor Liquitrol includes the Taylor Liquid Color Standards that are guaranteed unconditionally against fading. All sets made of non-warping plastic for light weight and long life.

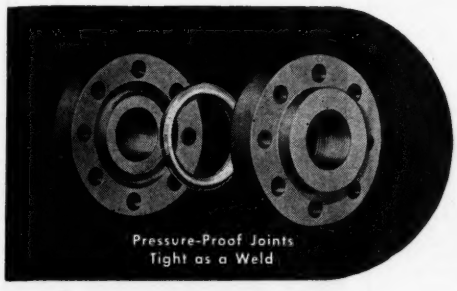
Valuable Book Free

84-page book contains detailed explanation of proper application of this type of control, methods, models and procedures used in The Taylor Liquitrol Method. See your dealer or write direct for literature.

W. A. TAYLOR AND CO.

7301 YORK RD. • BALTIMORE-4, MD.

PRESSURE-PROOF JOINTS for High Pressure and High Temperature Service are Obtainable with GRUV-SEAL, Forged Iron and Alloy, Ring Gaskets



Pressure-proof joints—tight as a weld—give relief from pipe line shutdowns. With Gruv-Seal "Forged Iron" Ring Gaskets, wrench pressure molds a tight seal that stays tight always—reduces power losses and other pipe line trouble. Gruv-Seal "Forged Iron" Ring Gaskets are machined to a fine, smooth finish, and fit perfectly. These gaskets should be used at all flange connections, valve bonnet joints, and at joints where ready disassembly is a necessary requirement. They are available in several different grades of metal for different services.

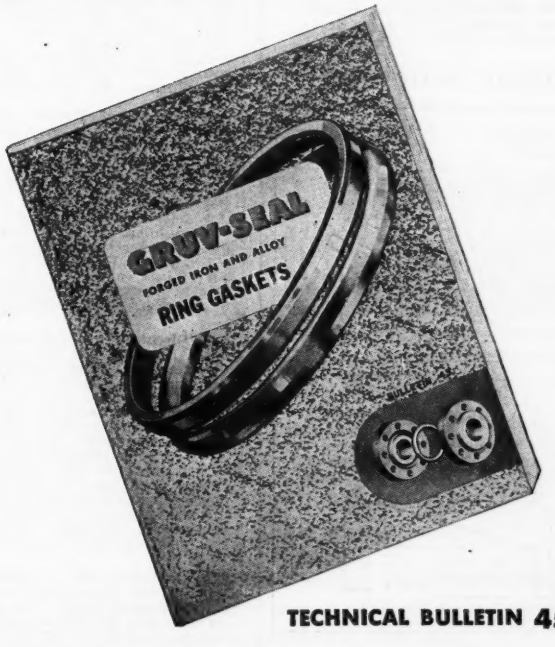
GRUV-SEAL "Forged Iron" Ring Gaskets are manufactured by a special forging method which eliminates metal porosity and interlocks the metal fibre lines into a dense, tough structure such as is obtained by no other fabricating process. Gruv-Seal "Forged Iron" Ring Gaskets are exact in every detail; true in diameter, circumference, and in thickness; perfectly proportioned and machined to a fine, smooth finish. The metal from which these are forged possesses corrosion-resisting properties beyond those of ordinary steels.

Gruv-Seal "Forged Iron" Ring Gaskets are forged in a wide range of sizes, including all standard A. P. I. sizes. New sizes are constantly being worked out as requirements occur. Write for special bulletin on Gruv-Seal "Forged Iron" Ring Gaskets.

These gaskets are one item of the complete line of Diamond "S" Forged Boiler and Tank Accessories which includes manhole cover assemblies, handhole cover assemblies, special welding street ells, all of which are forged to close tolerances from suitable metals, and fully meet and exceed A. S. M. E. requirements for steel use in pressure vessel parts.

Catalog No. 10 illustrates, describes, and lists a complete line of forged steel boiler and tank accessories, and contains technical data and general information about the application of such products.

THE STEEL IMPROVEMENT & FORGE CO.
966 East 64th Street • Cleveland, Ohio



TECHNICAL BULLETIN 45

Booklet 45 on GRUV-SEAL Forged Iron and Alloy Ring Gaskets contains description and illustrations showing application of these ring gaskets; also complete information on standard sizes and basic dimensions for A. P. I. and A. S. A. ring numbers and additional sizes for other services; also list prices for ring gaskets in five different grades of metals for different services. Write today for a copy.

DROP FORGINGS
THE STEEL IMPROVEMENT & FORGE CO.
966 East 64th Street • Cleveland, Ohio

VIKING

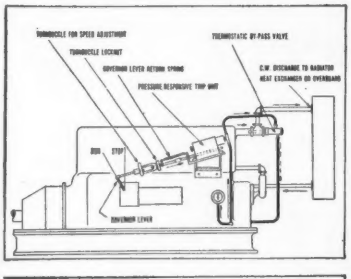
DIESEL ENGINE "SHUT-DOWN" SAFETY CONTROL

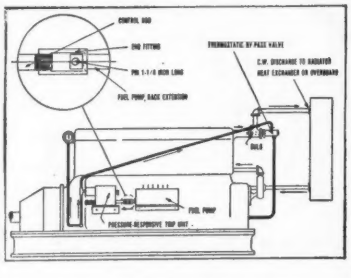
The Viking Type R-18 Shut-Down System for Diesel Engines, is a unique mechanically-operated safety control to shut down a diesel engine when (1) lubricating-oil pressure becomes too low, or (2) circulating-water temperature becomes too high.

Since it is mechanically operated this system does not require any electrical connections, and is free from operating failure due to blown fuses or other failure of electrical power sources.

A pressure-responsive bellows unit is connected in the lubricating-oil line and operates by trigger action a governor lever which shuts down the engine as soon as lubricating-oil pressure reaches the critical low point; similarly, a thermostatic by-pass valve in the circulating-water system will operate the lever when temperatures become excessive. Write for Data Sheet R-18.

TYPICAL APPLICATIONS





Other Viking Products

PRESSURESTATIC AND THERMOSTATIC CONTACT MAKERS

COMPLETE ALARM SYSTEMS

WALL-MOUNTED VISUAL INDICATORS

TACHOMETERS

★

VIKING INSTRUMENTS, INC.

403 Fairfield Ave. Stamford, Conn.

Telephone 4-7375

46 Putting Exhaust Heat To Work—Maxim heat recovery silencers provide effective silencing of engine exhaust noise and turn waste heat into steam or hot water for heating or process operation. Bulletin with typical silencer hook-ups shows how applications are made. The Maxim Silencer Co.

WATER TREATMENT

47 Zeolite Softeners—Booklet No. 2860-A describes greensand zeolite softeners for production of soft water. Cochrane Corp.

48 Modern pH and Chlorine Control—Bulletin describes scientific outfits and improved methods to step up boiler efficiency and prevent scale, corrosion, and embrittlement. W. A. Taylor and Co.

49 Control of Boiler Blowdown—Bulletin 21B gives methods for the control of boiler water concentration to produce the best quality steam. The advantages of continuous blowdown and a suitable control valve are also shown. National Aluminate Corp.

50 Corrosion In Process Equipment—Pamphlet by D. W. Haering & Co., describes the correction of an accelerated corrosion problem on the water side of process equipment used in the manufacture of synthetic dye-stuffs. Plant operations contributed to a wide fluctuation in the chemical constituents of the recirculating cooling water, with some increasing from 30 p. p. m. to over 4000 p. p. m. in a matter of minutes.

MISCELLANEOUS

51 Data On Welded Floats—Bulletin No. 345 describes Nicholson welded floats, sizes 2 to 14 in. diameter, for pressures from vacuum to 3000 lb. Used for dairy, cannery, chemical and steam specialty equipment. Bulletin has dimension tables, volume and buoyancy data, other useful information. W. H. Nicholson & Co.

52 Mechanical Rubber Goods—Neoprene tubing, rubber hose, gaskets, V-belts and other rubber goods are described with sizes and prices in latest catalog. Miller Products Co.

53 Coded Lubrication Service—Bulletin tells how newly announced code system numbers every lubricant used in your plant, marks every lubrication point with a bright decalcomania bearing code number of lubricant to be used there. System greatly simplifies machinery maintenance. Standard Oil Co. (Indiana).

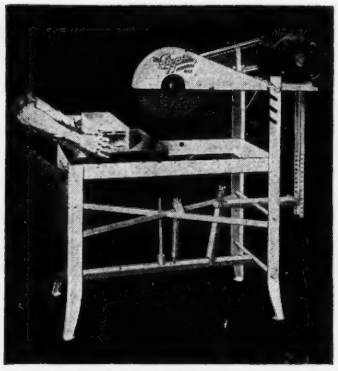
54 Directory of Engineering Literature—Allis-Chalmers Mfg. Co. announces a directory of products and engineering literature describing the lines of equipment it furnishes to nearly every industry. New products added since the previous directory, such as induction and dielectric heating equipment, are indicated by a star for easy identification. Engineering literature is arranged according to product discussed with new bulletins also starred. In most cases the literature contains operating data, charts, formulas, and technical information of value to the man who specifies and buys equipment.

55 Oil-Bath Air Cleaners—The Vortox Co. has issued new catalogs on Types G & GA and Types S & Sa triple-action air cleaners. Besides detailed specifications and dimensions on all models and accessories, the catalogs contain full data on selection of the proper size cleaner for any internal combustion engine or air compressor. Illustrations and diagrams covering design, operation and construction make these new catalogs easy to use; and separate price sheets on complete units, as well as parts and accessories, are provided to fit into each catalog between specification pages.

56 Welding Wire Handbook—A new digest of pertinent facts about Page electrodes and gas welding wires is just off the press. Each of its 33 pages contains information which will help make it easier for buyers to select the proper welding wire for their particular work. Includes physical properties, analyses of the weld metal deposit, operating characteristics, recommended current ranges and other necessary information. Page Steel & Wire Div. American Chain & Cable Co., Inc.

FASTER CUTTING ...with Clipper Masonry Saws

Your Special Size and Shape Brick or Tile can now be "Tailor-Made" at a moment's notice!

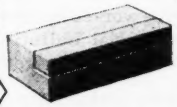


The new Clipper Multiple Cutting Principle makes possible faster cutting of every masonry material regardless of hardness.

Here are a few typical examples of the speed and accuracy with which fire brick can be cut for furnace repairs.

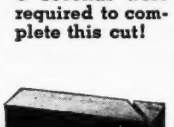
This acid brick intended for a chemical plant acid chamber was cut completely in two, in 37 sec.

One of many intricate cuts performed on first quality clay brick for heat treating furnaces. Made in 8 seconds.



Silica brick cut lengthwise for open hearth furnace work, only 9 seconds were required to complete this cut!

Basic refractories for steel furnaces or cement kilns must be accurately installed. This magnesite brick was cut in 12 seconds!

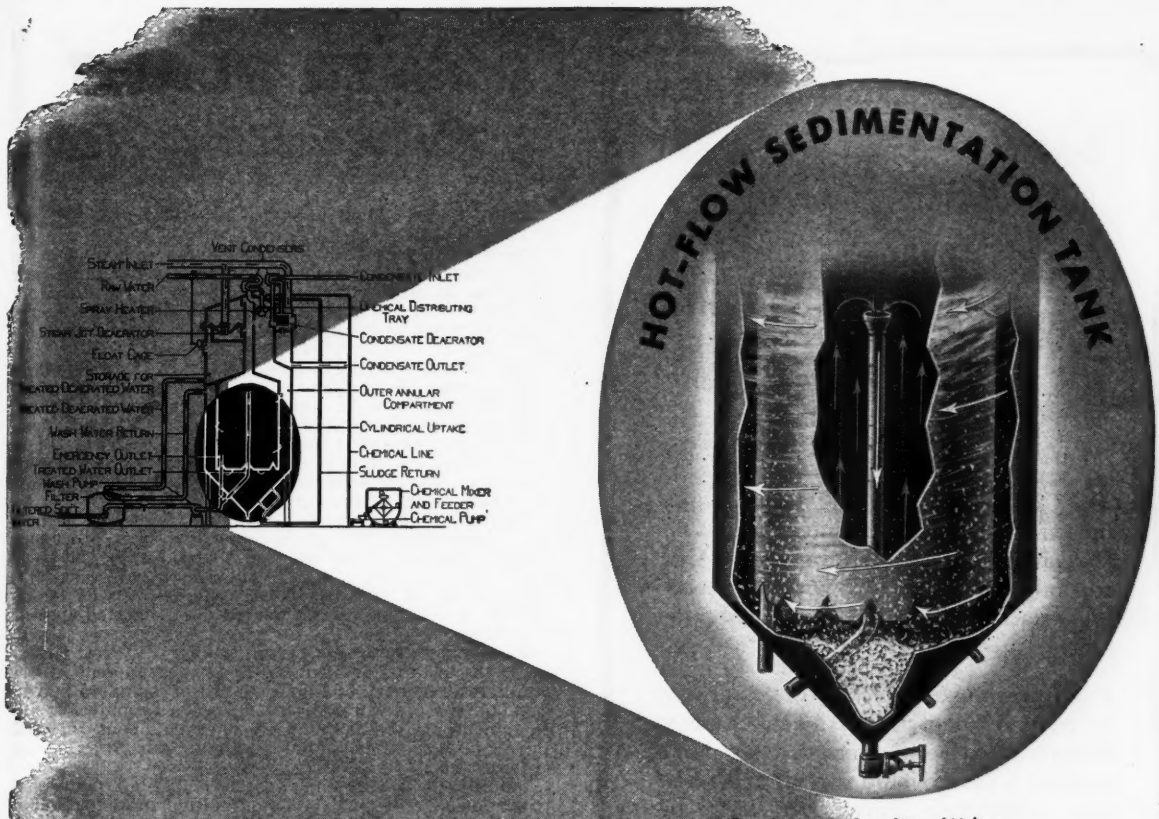


Clipper Saws are available for trial. Write for Descriptive Catalogs.

THE Clipper MANUFACTURING COMPANY

4018 MANCHESTER

ST. LOUIS, MISSOURI



Two Compartments of Equal Volume and Cross Sectional Area

HOT-FLOW SOFTENERS FOR BOILER FEED-WATER TREATMENT . . . .

PLUS VALUE No. 1 SEDIMENTATION TANK DESIGN

EQUAL VOLUMES: The water must spend half its retention time traveling down the outer compartment—so chemical reactions are completed and solids precipitated long before the water turns upward into the inner compartment.

EQUAL CROSS SECTIONS: There is no variation in velocity of forward travel from inlet to outlet—not even at the point of change in direction of flow.

Thus, this design feature establishes an operating condition conducive to maximum solids separation and sedimentation. The result is an ample volume of properly settled, relatively clear water always ahead of the filters, and this

- **permits 350% overload when backwashing**
- **permits full recovery of wash water**
- **increases the length of filter runs**
- **increases the life of filtering media**
- **reduces operating attention required**
- **eliminates the need for any coagulant**
- **assures high clarity of filter effluent.**

INFILCO

INFILCO
INCORPORATED
325 WEST 25th PLACE • CHICAGO 16, ILL.

Before you buy any ★Breechings . . .

Get a CONNERY CONSTRUCTION Estimate

RECENT orders from Pennsylvania Edison Co., Dunn Sulphite Paper Co., Standard Oil Co., American Viscose Co., and other concerns for Connery breechings, stacks, flues and ducts are significant.

From previous experience, the engineers on many of these projects knew Connery Construction meant units that wouldn't warp or buckle; would stay air and moisture tight; help increase efficiency of draft; show marked savings in plant maintenance.

Because simplified and durable Connery Construction makes your building dollars go further, it will pay to get a Connery bid before you buy any breechings, stacks or other fabricated steel plate work. Write for Connery Handbook with specifications and typical installation pictures.

CONNERY CONSTRUCTION CO.

Second and Luzerne Streets

PHILADELPHIA, PA.

★ Connery Construction is electrically welded; Accordion-type Expansion Stiffener makes it buckle and warp proof, air and moisture tight. Let us tell you more about it for your jobs.

POWER PLANT Construction News

Calif., Salida—Shell Chemical Co., 100 Bush St., San Francisco, Calif., subsidiary of Shell Oil Co., Inc., same address, plans installation of electric power equipment in new agricultural and research laboratory at Salida, near Modesto. It will consist of a large group of one-story buildings with utility structures, including boiler house. Cost estimated about $500,000. Work is scheduled to begin soon.

Fla., Miami—Theobald Industries, Inc., ft. of Sandford Ave., Kearny, N. J., tallow, soaps, stearic acid, etc., plans installation of electric power equipment in new branch plant at Miami, where site has been selected. It will comprise several one-story buildings. A boiler house will be built. Entire project will cost about $225,000. Application has been made for a priority rating. Steward & Skinner, Ingraham Bldg., Miami, are architects.

Fla., Plymouth—Florida Foods, Inc., Dock and Granite Sts., Philadelphia, Pa., plans new citrus fruit processing plant at Plymouth, near Apopka, for production and packing of citrus concentrates. It will consist of several one-story buildings. Electric power equipment will be installed. A boiler house is planned. Cost reported close to $1,000,000.

Ill., Chicago—American Colortype Co., 1151 West Roscoe St., plans installation of electric power equipment in new two and three-story addition to printing plant, to be carried out as a postwar project, or as soon as materials and equipment are available. Cost reported about $500,000. Burnham & Hammond, 160 North LaSalle St., Chicago, are architects.

Ind., Brazil—Bd. of Public Works, City Hall, plans electrification of municipal pumping station used for waterworks system, replacing present steam operation. Motor-driven pumping machinery and auxiliary equipment will be installed. Proposed to engage engineer soon to make surveys and estimates of cost, with project to be carried out as a postwar development.

Iowa, Dubuque—John Deere & Co., Moline, Ill., agricultural machinery, will build a power house, 80 x 120 ft, in connection with new plant to be erected near Dubuque, at place known as Peru Townsite. Entire works will comprise a group of 11 buildings, including three main production shops, each one-story, 140 x 420 ft, and assembling building, 120 x 500 ft. Electric power equipment will be installed. Complete plant will cost over $4,000,000. Erection will begin soon.

Iowa, Essex—Town Council has preliminary plans under consideration for a municipal light and power plant, and has called special election to approve project. Proposed to install a Diesel engine-generator unit and auxiliary equipment.

Iowa, Shenandoah—Town Council is considering a municipal light and power plant, with Diesel engine-generator unit and auxiliary equipment. A special election has been called to approve project and necessary financing.

Md., Bainbridge—Bureau of Yards and Docks, Navy Department, Washington, D. C., new enclosed steel unit-type power substation at Naval Training Center, Bainbridge, to cost about $49,000. Also will build new one-story public works shop to cost approximately $650,000. Electric power equipment will be installed.

Mich., Three Rivers—Electric Light Department, Sturgis, Mich., has surveys and estimates of cost under way for extensions in municipal hydroelectric generating station at Three Rivers, with installation of new hydraulic turbine, electric generator and accessory equipment. Work will be carried out as a postwar development. Ayres, Lewis, Norris & May, Ann Arbor, Mich., are consulting engineers.

Minn., Winona—Winona Knitting Mills, Inc., 902 East Second St., plans installation of electric power equipment in new four-story mill addition, totaling about 22,500 sq ft floor space. Cost estimated about $160,000. George H. Burrows & Associates, Shaker Sq., Shaker Heights, Cleveland, Ohio, are architects.

Mo., Springfield—City Hospital Department, City Hall, plans one-story and basement boiler house, 31 x 48 ft, in connection with new two and three-story municipal hos-

THOUGHTFUL BUYING

Outwardly, flanges look very much alike no matter who makes them. It's *how* they're made and what they're made of that determines the difference.

That's why it pays, when buying flanges for any purpose, to give careful thought to the underlying factors which govern their real value.

Phoenix Flanges are drop-forged from a mild steel that is especially suited to welding and machining . . . a steel that has proven most satisfactory from every standpoint. They're forged to exacting specifications in dies that insure proper grain flow and therefore maximum strength and toughness at points of greatest stress. And they're ground and finished in automatic precision machines to meet the most exacting requirements.

Those are the things the thoughtful buyer looks for . . . and finds in Phoenix Flanges. Incidentally, it's a good idea to have the new Phoenix Flange Catalog at your finger tips. If you haven't received your copy, write for it today. No cost . . . no obligation.

Flange Division of

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. JOLIET, ILLINOIS

Phoenix Drop-Forged Steel Flanges are available in a wide range of styles and sizes. They can also be supplied in Everdur brass, stainless steel, and other alloys. Every Phoenix Flange complies with ASA requirements and ASME and ASTM specifications.

PHOENIX
Drop Forged
FLANGES

It's true . . . the discs and seats on EVERLASTING valves *are* hand-lapped to secure the drop-tight seal when the valves are built. But it's the repeated self-grinding, self-polishing, SELF-LAPPING of the disc on the seat—every time this valve is used — that maintains the famous EVERLASTING drop-tight seal . . . *without maintenance!*

WITHOUT MAINTENANCE

This valve disc does not merely slide open and closed, as in the usual gate valve. This disc actually *rotates* within the disc-arm as it moves across the seat . . . SELF-LAPPING these sealing faces to microscopic precision. And the disc travels in constant contact with, and on, the seat table—they're never separated—so no grit or other substance can lodge between these sealing faces. The EVERLASTING drop-tight seal truly *improves with use!*

IMPROVES WITH USE

Changes of temperature cannot cause this valve to bind, because *all parts* function in a parallel plane . . . are free to self-compensate any expansion or contraction of individual parts. The disc, like all other internal parts, cannot become loose and choke the straight-through flow. And, since there is absolutely no wedging action in this valve—it *cannot stick!*

CANNOT STICK

A DEPENDABLE valve, well worth your learning more about—so why not write today for our Bulletin?

EVERLASTING VALVE CO., 49 Fisk St., Jersey City 5, N. J.

Everlasting Valves

for everlasting protection

pital, with installation to include one high-pressure and two low pressure boilers, and auxiliary equipment. Entire project will cost about $225,000. Daniel R. Sanford & Sons, Woodruff Bldg., Springfield, are architects. Proposed to ask bids in near future.

Ohio, Bellevue—Nickel Plate R. R., Terminal Tower Bldg., Cleveland, plans new boiler house at shops at Bellevue, in connection with expansion in machine shops, engine house and other yard structures. Considerable increase in present capacity will be carried out. Entire project reported to cost about $1,500,000, with machinery, electric power equipment and other facilities. J. C. Wallace, first noted address, is engineer.

Ohio, Cleveland—Light and Power Department, City Hall, has authorized surveys and estimates of cost for expansion in municipal power plant, and extensions and improvements in lighting system in different parts of city, to be carried out as a postwar project. Currently reported that program will approximate $10,000,000 for entire development. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., is consulting engineer.

Ohio, Franklin—Miami Valley Coated Paper Co., plans expansion in power house at mill, including installation of new 250-hp boiler and auxiliary equipment, stoker, soot blowers, etc. No estimate of cost announced. Project has a priority rating and work will begin soon.

Ore., Klamath Falls—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans boiler house for central-heating service at new rehabilitation center at Klamath Falls, to cost about $300,000, with boilers and auxiliary equipment. Entire program will comprise a large group of buildings for various service, with electrical distribution system and other electrical facilities, and is estimated to cost $3,367,000.

Pa., Philadelphia—Bureau of Yards and Docks, Navy Department, Washington, D. C., will have plans prepared soon for extensions and improvements in central power plant at Navy Yard, Philadelphia, with installation of equipment for increased capacity. Fund of $700,000 has been authorized for project.

Pa., West Pittsburgh—Pennsylvania Power Co., 19 East Washington St., New Castle, Pa., has authorized expansion and improvements in steam-electric generating station at West Pittsburgh, with installation of new 35,000-kw, turbine-generator unit, high-pressure boilers and accessory equipment. Capacity of plant will be doubled. Also will make extensions in transmission lines. Entire project will cost about $3,000,000. It is understood that a priority rating has been secured.

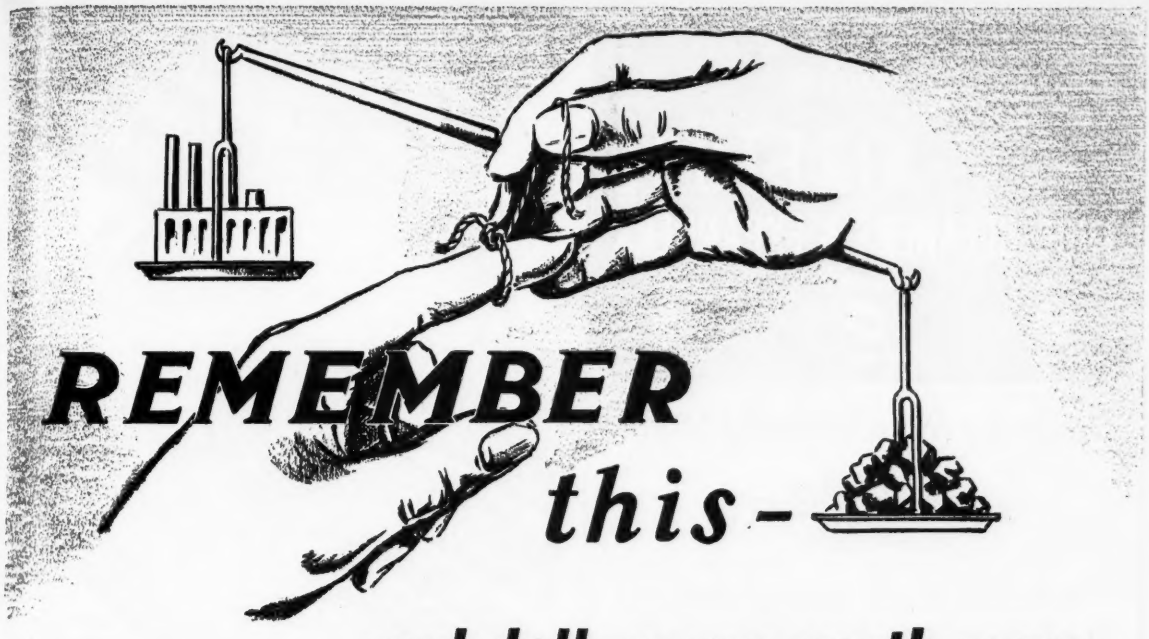
Va., Blacksburg—Board of Directors, Virginia Polytechnic Institute, has plans under way for extensions and improvements in power plant at institution, used for central-heating service, including installation of new 500-hp boiler and accessories, water softeners, fly ash eliminators and other equipment. Program will be carried out in connection with other expansions at Institute, entire project to cost about $1,000,000. It is understood that this will be a postwar project. Wiley & Wilson, Peoples National Bank Bldg., Lynchburg, Va., are engineers.

Va., Norfolk—Bureau of Yards and Docks, Navy Department, Washington, D. C., has arranged appropriation of $600,000 for extensions and improvements in underground steam distribution system at Naval Operating Base, Norfolk. Work is scheduled to be carried out soon.

Wash., Blaine—Bonneville Power Administration, Failing Bldg., Portland, Ore., plans new 230,000-volt transmission line from Arlington, Wash., to Blaine, near Bellingham, about 69 miles, for power supply for British Columbia Electric Railway, Inc., Vancouver, B. C. Power substation will be built at Blaine terminus, with another 230,000-volt line to be built by railway company to Vancouver, where another power substation will be located. Application has been made for permission to WPB.

Wis., Merrill—Ward Paper Co., Mill St., plans installation of electric power equipment in two new additions to mill, about 80 x 145 ft, and 36 x 54 ft, respectively. Cost reported over $85,000, with machinery. Proposed to begin work soon.

Wis., Washington Island—Washington Island Electric Co-operative, Charles O. Hansen, acting secretary, has plans in progress for new generating station, with installation to include three 50-kw Diesel engine-generator units and auxiliary equipment. A power substation for set-up service will be built. Bids are scheduled to be asked early in Sept. Carl C. Crane, Room 321, 119 East Washington Ave., Madison, Wis., is engineer.



. . . coal dollars are worth more than equipment dollars . . .

Modernization for many plants is a "must," if steam generation is to meet tomorrow's standards of efficiency and economy.

The prospect of quick amortization of your investment in modernization emphasizes the importance of the coal dollar when that dollar is spent for coal that will be available long after the equipment to burn it has been paid for in savings.

To avoid being "penny-wise and pound foolish" remember this: YOU WILL BE FULLY JUSTIFIED IN MAKING AN EXTRA INVESTMENT TO ADAPT YOUR COMBUSTION AND FURNACE EQUIPMENT TO USE A WIDE RANGE OF AVAILABLE COALS BY THE SAVING IN COAL DOLLARS YOU WILL MAKE.

An investigation of FAIRMONT COAL will disclose the reasons why it is playing such an important part in the plans of engineers charged with building tomorrow's efficiency into today's plants.

Important information for any engineer planning modernization is contained in "Coal Reference Bulletins" which will be sent promptly on request. Use coupon below.

▶LOW FUSION FAIRMONT COAL CONSERVES COAL DOLLARS

. . . it can be burned economically in any equipment properly designed for its use.

. . . it will be available for many years to come because of its huge reserves.

. . . it represents high fuel-dollar value.

. . . it reduces overall steam cost for any plant designed for its use.

FAIRMONT COAL BUREAU *Chanin Bldg., 122 E. 42nd St., New York 17, N. Y.*

FAIRMONT COAL BUREAU · FAIRMONT REGION · WEST VIRGINIA · SERVICE TO INDUSTRY

FAIRMONT COAL BUREAU, Chanin Bldg., 122 E. 42nd St., New York 17, N. Y.

MAIL COUPON TODAY

Kindly place me on your mailing list to receive copies of "Coal Reference Bulletins." It is understood these will be sent FREE and without obligation.

Name .....

Company .....

Position .....

Street Address .....

City ..... Zone ..... State ..... P.P.E.

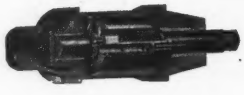
Here's why

AIRETOOL

TUBE CLEANERS & EXPANDERS

SAVES TIME · SAVES TUBES · SAVES $ MONEY

Driven By More Powerful Motor



Airetool Tube Cleaners and Expanders are driven by a power seal motor that develops up to 28% more power. Can be loaded down to 50 rpm. without stalling. Has slip fit construction for easy maintenance. For tube sizes ½" to 24" I.D., straight or curved.

New Form Cutters

New Form Cutters are precision made of special heat treated alloy steels for prolonged usage. Designed to remove severe deposits in tubes quickly and efficiently without tracking. Made in a variety of styles and sizes.

Tough Tube Expanders

Airetool Tube Expanders are made of heat treated alloy steels for greater endurance. No tube expanding job is too tough for them. Many styles and sizes.

HELPFUL BULLETINS

are available which explain Airetool products. Write for your copies.

Dept. PY

Airetool & Yost Superior Factory Bldgs.

Springfield, Ohio

AIRETOOL MANUFACTURING COMPANY

LIQUIDOMETER

Tank Gauges

ALWAYS DEPENDABLE

WRITE for COMPLETE DETAILS

"LIQUIDS WORTH STORING ARE WORTH MEASURING"

THE LIQUIDOMETER CORP.

36-31 SKILLMAN AVE., LONG ISLAND CITY, L.N.Y.

MERCOID CONTROLS

FOR OIL BURNERS, STOKERS, GAS BURNERS, REFRIGERATION, AIR CONDITIONING AND VARIOUS INDUSTRIAL APPLICATIONS

Pressure Control

USE MERCOID "DA" CONTROLS FOR THOSE TEMPERATURE AND PRESSURE PROBLEMS

Both controls are available in a number of ranges

Mercoid Controls have an advantage, because they are equipped exclusively with Mercoid DUST-PROOF switches —hence the assurance of better control performance, longer control life and greater economy in control value.

THE MERCOID CORPORATION • 4213 BELMONT AVE. • CHICAGO, ILL.

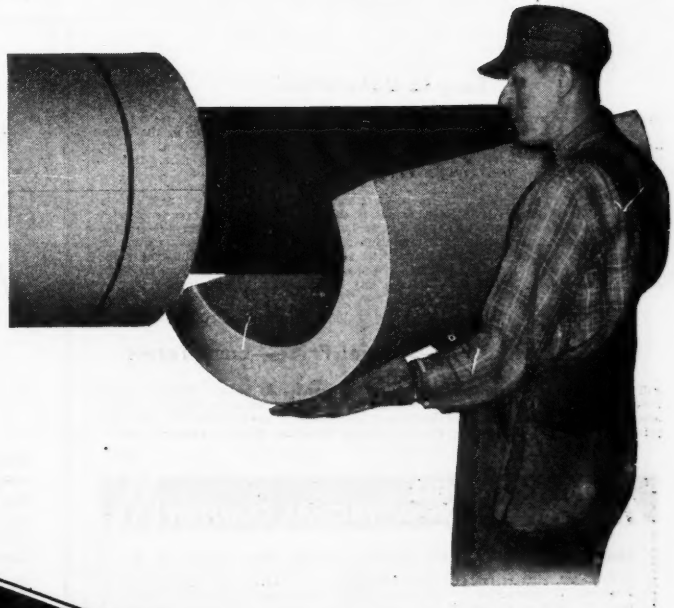
TROUBLED BY "MIDDLE-AGE SPREAD"?

SIMPLY APPLY UNIBESTOS

it's simple to apply!

Unibestos, the sectional insulation, will not dent, shatter, sag or gap as the result of vibration, exposure to moisture or hard knocks. This greater structural strength is a result of Unibestos' resilient, tough fibrous construction.

Unibestos is available in half-section form up to 30" pipe diameter and in quarter sections from 32" to 60", in thicknesses from ¾" to 5". Single layer construction is available for service up to 1200°.



UNION ASBESTOS

MEANS PROGRESS IN INSULATION

AND RUBBER CO.

COPYRIGHT
UNION ASBESTOS AND RUBBER CO.

PLANTS: 1821 S. 54th Ave., CICERO, ILL. • PATERSON, N. J. • BLUE ISLAND, ILL.
OFFICES: CHICAGO • CICERO, ILL. • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

There's always room and BIG PAY in POWER

War or peace, keeping the wheels of industry and the nation's utilities turning is a basic job—one there's always room and big money in for the expert. Take the short-cut way to a better-paying power plant job. Do as thousands of others have, to their definite gain—spend a short time daily and systematically reading and using these books.

The Library of POWER PLANT PRACTICE

(6 volumes—2,477 pages, 2,404 illustrations)

These six books cover the subjects of power plant practice completely and in every detail from the foundations and coal passing to the very tops of plant smoke stacks. They give you knowledge of boilers, steam engines, steam turbines, pumps, boiler-feed apparatus, and other equipment—their construction and performance—how to select them—how to test and maintain them—how to improve efficiency and economy in operating them. Descriptions, instructions, data, questions, problems and answers, more than 2,000 detailed diagrams and illustrations—make clear **why** as well as **how** to do the work.

Easy to Understand

These books are written in everyday easy-to-understand language. They are written to help the man on the job. It is just as if the author were working in the plant by your side and giving you the benefit of his vast knowledge, man to man. There's no bunkum in this Library, nor is it cluttered up with impractical theories. It is a **Power Plant Library FOR POWER PLANT MEN.**

The Library of Power Plant Practice is the standard of the power plant field. It is accurate—it is thorough—it is complete. It is the result of years of experience with power plant problems. The man who has it has the best. The Library covers the whole field—nothing is omitted. The solution of every problem is plainly worded or explained with a clear illustration. The little stickers and the big troublesome problems are all worked out in advance for you. There can be only one result from studying these books a few minutes each day—more money in your pocket.

Free Examination—Special Price—Easy Terms

Fill in and mail the coupon below and we will send you the six volumes of the Power Plant Library for 10 days' Examination. If you decide to keep the books after examining them, just send $2.00 and then $2.00 a month until the total low price of $16.00 has been paid. See the coupon below for details. Send it now.

McGRAW-HILL ON-APPROVAL COUPON

McGRAW-HILL BOOK CO., 330 W. 42nd St., New York 18, N. Y.

Ship to me, charges prepaid, the six volumes of the **Library of Power Plant Practice.** If satisfactory, I will send $2.00 in ten days and $2.00 a month until the price of $16.00 has been paid. If not wanted I will return the set to you postpaid. (To insure prompt shipment write plainly and fill in all lines.)

Name.....

Home Address.....

City and State.....

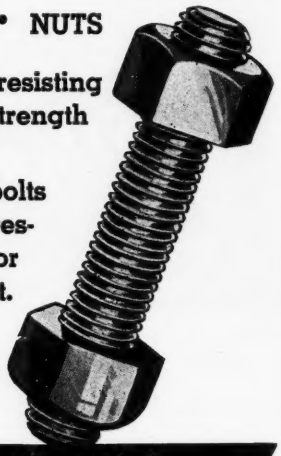
Position.....

Firm or Employer.....PPE-8-45

VICTOR Custom FASTENINGS

for Power Plants and All Heavy Industries

STUDS • BOLTS • NUTS



Heat and corrosion resisting metals and high strength alloy steels.

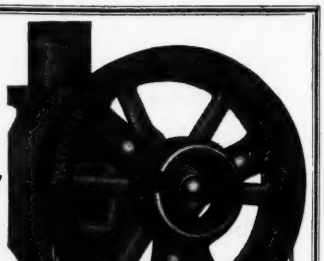
Alloy steel studs, bolts and nuts for high pressure uses stocked for immediate shipment.

LET US QUOTE ON YOUR REQUIREMENTS

Write for Catalog

Write for complete catalog!
VICTOR PRODUCTS CORP.
2639 Belmont Ave. • Chicago, Ill.

For All "HIGH-UP" VALVES

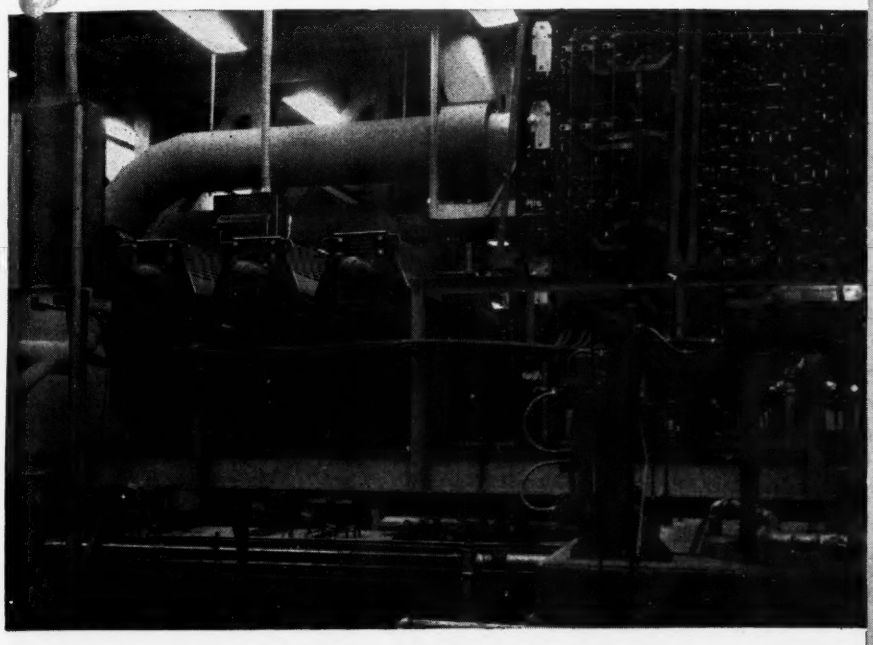


Every overhead valve in your plant should have the easy, safe, instant control from the floor which Babbitt Sprocket Rims provide. . . . Babbitt Rims are low in cost; quickly attached; they save time, steam and accidents. Install them now. Write for descriptive folder.

BABBIT STEAM SPECIALTY CO.
South Water, Spring and First Sts.
New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

6 THINGS TO NOTICE in this picture



1. The dry-type transformers are close to the load, yet out of the way.
2. There are no long runs of heavy copper.
3. No expensive, space-stealing fireproof vaults are required.
4. The transformers are totally metal enclosed for safety.
5. Little installation space is used.
6. The slanted-louver construction, top and bottom, to assure cool operation. (The "chimney effect" produced by this construction carries away heat rapidly.)

THEY'RE ALL ADVANTAGES YOU CAN HAVE WITH

G-E TYPE D TRANSFORMERS

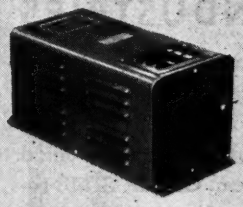
DO YOU REALIZE the many jobs on which you can use small G-E dry-type transformers to advantage? Insulating lighting circuits from power circuits, boosting low line voltage, and supplying the right voltage for the most economical operation of motors, machine tools, and welding apparatus are only a few of their many money-saving applications.

Stay cool; save space—Type D transformers are cooled by natural-draft ventilation. Their unique case construction aids the flow of ventilating air through the transformer coils. They can be installed against a wall or close to other units with little or no effect on the temperature rise of the transformer. Because of this fact, considerable space can be saved, especially when a number of these transformers are to be banked. (For example, the above installation in a midwestern plant. Here, only a small platform is required to take care of six 100-kva units to supply 230-volt annealing furnaces.)

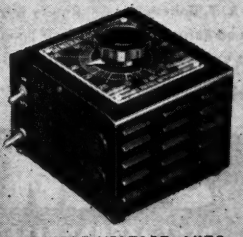
Easy to install; maintenance negligible—As these transformers are small, compact, and lightweight, and do not require a fireproof vault, they can be installed almost anywhere you wish. The ease of disassembly and reassembly of case parts permits quick inspection and cleaning, when necessary. Operating records show that little or no maintenance is required.

Type D transformers are available in ratings up to and including 100 kva—600 volts and below. For further information, ask for Bulletin GEA-897. *General Electric Company, Schenectady 5, N. Y.*

OTHER G-E AIDS TO BETTER VOLTAGE



VOLTAGE STABILIZER—Automatically provides a constant 115-volt supply to a given load, on circuits varying from 95 to 130 volts. Ratings from 50 to 5000 va. Ideal for precision laboratory or manufacturing processes, or built into such equipment as radio transmitters.



VARIABLE-VOLTAGE AUTO-TRANSFORMER—Provides smooth, adjustable control of voltage, current, light, temperature, power, and speed at a turn of the dial. Ratings from 243 to 810 va. Ideal for use in factories, laboratories, and assembled with other equipment.

AIR-COOLED REGULATORS—Automatic type: for secondary circuits (10% regulation, raise and lower). Remote-motor or hand operated: for laboratory or testing (100% raise and lower). Ratings up to 12 kva, 600 volts.

THE RIGHT VOLTAGE AT THE RIGHT PLACE DOES THE JOB **BETTER**

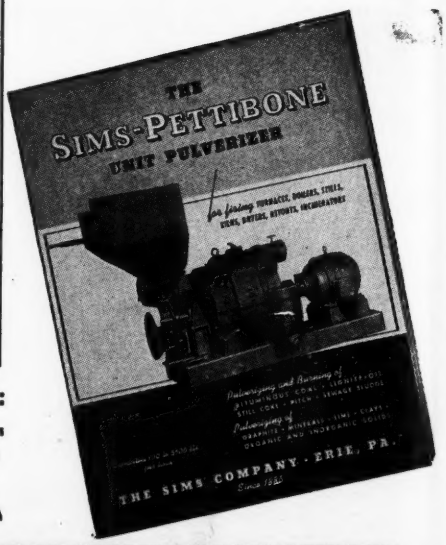
GENERAL ELECTRIC

S-P UNIT PULVERIZERS IN THESE INDUSTRIES

Sims-Pettibone pulverizers have a wide background of application and performance behind them. Consult SIMS today for operating facts and figures to prove their economy and dependability. Write for booklet.

Furniture Plants
Railroads
Mill Plants
Hospitals
Chemical Plants
Dye and Finishing Plants
Silverware Manufacturer
Water Works
Oil Refineries
Lime Plants
Asbestos Products
Schools
Sewage Plants
Greenhouses
Tanneries
Tanning Extracts
Forge Plants
Sugar Refining Plants
Brick Kilns
Laundries
Cotton Mills
Cordage Works
Breweries
Cork Plants
Wire Works
Iron and Steel Processing Plants

Write for Catalog



S-P UNIT PULVERIZERS ARE FIRING:

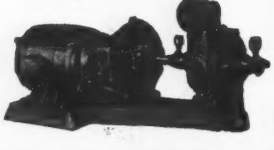
H. R. T. Boilers
Wood Refuse Furnace
Tar and Pitch Stills
Rotary Kilns or Dryers
Shaft Lime Kilns
Brick Kilns
Water Tube Boilers
Continuous Oil Stills
Batch Type Oil Stills
Reverberatory Furnaces
Sewage Sludge Dryers
Bone Charcoal Kilns

THE SIMS COMPANY • BOX 1096A • ERIE, PENNSYLVANIA

SIMS *Heat Recovery Products*

HEAT EXCHANGERS • EXHAUST GAS BOILERS • ENGINE SILENCERS • STORAGE WATER HEATERS
OIL HEATERS • OIL COOLERS • FEED WATER HEATERS AND UNIT TYPE PULVERIZERS

The Key to



BLACKMER PUMPS

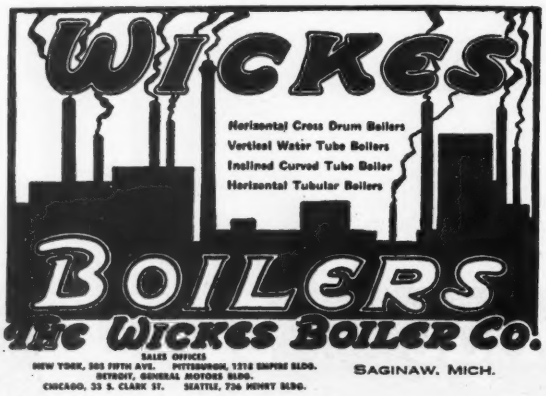
- LOWER PUMPING COSTS
- SUSTAINED PUMPING CAPACITY
- PUMP DEPENDABILITY

Write for Bulletin No. 306—FACTS ABOUT ROTARY PUMPS—which explains why the "Bucket Design" (swinging vane principle) maintains pumping capacity by automatically compensating for wear and how the buckets, when finally worn out, are easily replaced and the pump restored to its normal capacity.

SERVING INDUSTRY FOR OVER 40 YEARS

BLACKMER PUMP COMPANY, 2010 Century Avenue, Grand Rapids 9, Michigan

POWER PUMPS • HAND PUMPS • EZY-KLEEN STRAINERS



C. H. Wheeler of Philadelphia

STEAM CONDENSERS
•
STEAM EJECTOR TYPE VACUUM PUMPS
•
MECHANICAL DRAFT WATER COOLING TOWERS
•
DECK MACHINERY

C. H. WHEELER MFG. CO.
19th ST. and LEHIGH AVENUE, PHILADELPHIA 32, PA.

AN OPPORTUNITY

to modernize your tube cleaning operations with

ROTO TUBE CLEANERS

If your tube cleaning equipment is out of date or worn beyond ordinary repair, you can now secure modern Roto Tube Cleaners directly from stock, regardless of priorities.

While sales to war industries, the armed forces, and Allied merchant navies are now at the highest level in our history, we are able to meet additional normal demands for Roto Tube Cleaners because of recently enlarged and improved production facilities.

With the powerful new Roto Tube Cleaner, featuring one-man operation, your tubular equipment can be maintained at top efficiency with minimum cost.

Write, wire or phone your nearest Roto representative, or contact us directly.

ROTO DIVISION of ELLIOTT COMPANY

145 Sussex Avenue Newark 1, N. J.

3 Reasons Why STONHARD RESURFACER Solves Floor Problems

1 PATCHING . . .

Ease of application makes STONHARD RESURFACER particularly valuable for patching ruts, holes and breaks in floors.

BECAUSE: Stonhard Resurfacer *does away with heating of materials and chopping up the old surface.*

2 TRUCKING SURFACES . . .

STONHARD RESURFACER can be laid down *where it is needed most,* where trucking is heaviest. *Stonhard Resurfacer* proves most beneficial here as it actually improves with heavy trucking traffic.

BECAUSE: Stonhard Resurfacer *forms a hard, tough, yet resilient surface.*

3 COMPLETE FLOOR RESURFACING . . .

Its excellent, enduring and elastic qualities make complete overlays with STONHARD RESURFACER ideal not only for existing surfaces, but also for new construction as well.

BECAUSE: Stonhard Resurfacer *is easy and economical to apply . . . does not require skilled labor.*

STONHARD RESURFACER CAN BE APPLIED OVER ANY TYPE OF FLOOR
Concrete, Wood, Brick or Composition

TRIAL OFFER

A drum of STONHARD RESURFACER will be sent on trial to any responsible firm or institution. Test its performance for 30 days under actual working conditions. If not satisfactory, we will cancel our invoice.

STONHARD COMPANY
Building Maintenance Materials
Serving the Railroads, Utilities and Industries Since 1922
401 N. BROAD ST., PHILADELPHIA 8, PA

Write for
FREE FOLDER
"No Need for Floor Sculpture"
No Obligation

STONHARD COMPANY
811 Terminal Commerce Bldg.
Philadelphia 8, Pa.
Please send us more detailed information on STONHARD RESURFACER.

FIRM.....
ADDRESS.....
MR.....TITLE.....
CITY.....ZONE.....STATE.....

"PENNSYLVANIA"

In modern Central Station design, Engineers familiar with their accurate sizing, automatic refuse removal, and low overall operating cost, usually locate Bradford Coal Breaker and Cleaner Equipment, somewhere between the Track Hopper and the Bunkers.

There are over 50 of these installations in the U. S. A., and 3 more in process.

The cut shows a "Pennsylvania" Bradford installation, which has prepared over 10,000,000 tons of coal, at nominal power and negligible maintenance cost.

The installed capacity of "Pennsylvania" Coal Preparation Equipment, at home and abroad, now approximates 300,000,000 tons per annum.

We Will Be Glad to Furnish Performance Data.

New York • Pittsburgh
Chicago • Los Angeles
PENNSYLVANIA CRUSHER COMPANY
Associated with Fraser & Chalmers Eng. Works, London

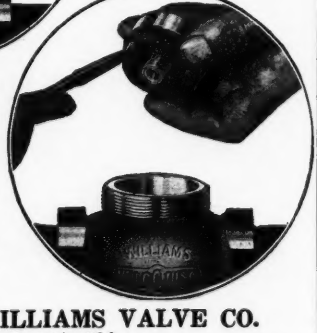
1706 Liberty Trust Bldg., Philadelphia 7, Pa.

COAL PREPARATION

Use **VULCODISC**

for trouble-free valve jobs

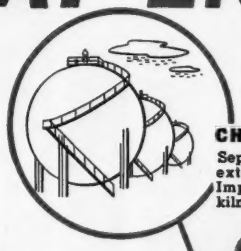
In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact, its absorption is less than 1 per cent. . . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

New Jobs for *PREHEAT ENGINEERING*

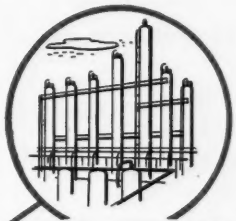


CHEMICAL PLANTS

Separately-fired units for extra-high superheat — improved operation of kilns and dryers.

WASTE DISPOSAL PLANTS

To increase by-products and add both efficiency and speed to waste disposal by supplying high-temperature air for dehydration.

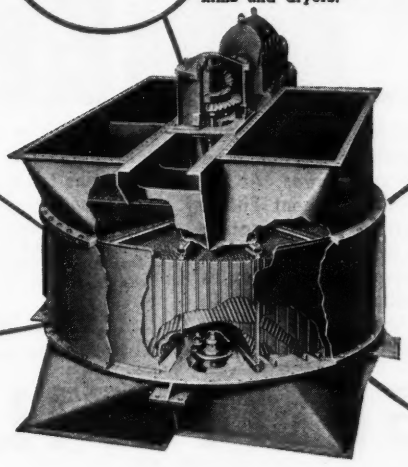


OIL REFINERIES

Heat recovery on cracking stills.

WHAT HAVE YOU?

Maybe you have some process which could profitably use preheat engineering.



THE *Ljungstrom* AIR PREHEATER

The continuous, regenerative, counterflow principle of the Ljungstrom Air Preheater provides maximum heat transfer with minimum size and weight. The rotating, cylindrical heat transfer surface absorbs heat in the gas chamber; then rotates to the chamber where it gives up this heat to the entering air.

SMELTERS

To increase temperature and output of reverberatory smelter furnaces, where capacity increases up to 50 per cent may be anticipated.

YEAR after year, industry puts the Ljungstrom Air Preheater to work at new tasks, performing them better or more economically than before. Many of these new applications are far removed from the primary function of waste heat recovery at steam generating plants.

Today, refinery, synthetic rubber and metallurgical applications of the Ljungstrom are widespread, and increasing. Among the newer users of the Ljungstrom are chemical plants, refineries, smelters and waste disposal plants.

Other industries are investigating the possibilities of the Ljungstrom applied to their processes. If you are using heated air or gas for any purpose, it may pay you to investigate the possibilities of the Ljungstrom Air Preheater in speeding processes and cutting costs wherever gas-to-air, gas-to-gas or air-to-gas heat transfer is needed.

ENGINEERING SERVICE

The engineering staff of the Air Preheater Corporation is prepared to assist you in applying standard or special types of Ljungstrom Preheaters to your individual need.

To get full benefit of preheat engineering, we suggest that you call in the preheat engineer while plans for remodeling or new construction are still in the formative stage.

THE

AIR PREHEATER

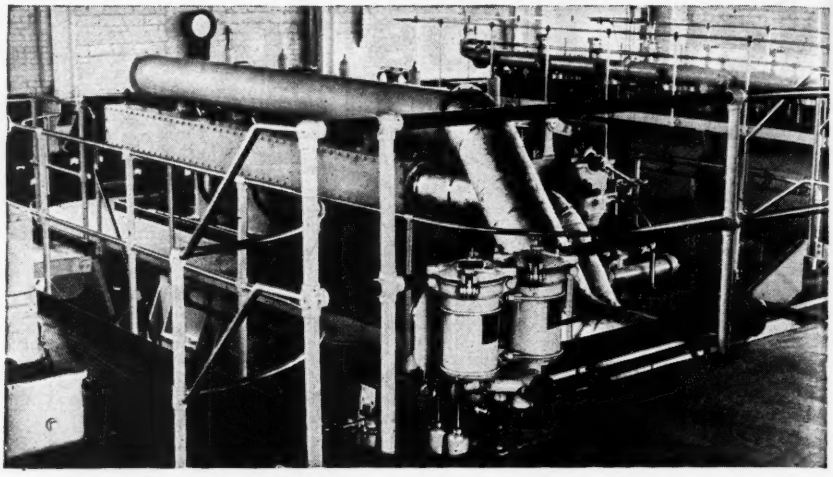
CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, N. Y.

6 NUGENT FILTERS..

Help Protect Diesels at Maquoketa, Ia.

Electric Plant



Today when the total generating capacity of the nation's power plants is vital, it is more important than ever to eliminate the possibility of shut-downs. At the Maquoketa Municipal Electric Plant, Nugent Filters help to insure uninterrupted service by eliminating dirt from the fuel oil used in the Diesel engines.

These rugged filters will remove dirt particles as small as .0017" to assure virtually 100% clean oil. This is the kind of protection that is essential for smooth, dependable Diesel operation. Available in a wide range of sizes for Diesel engines from 1 to several thousand HP in single containers. Write for bulletins today.

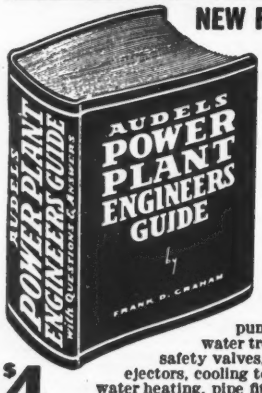
The 1200 HP, 8 cylinder mechanical injection type McIntosh-Seymour Diesel engine shown above is one of four Diesel engines at this location equipped with Nugent Filters. The Duplex unit shown is installed between the day tank and the engine to cleanse the fuel oil.

WM. W. NUGENT & CO., INC.
423 N. Hermitage Ave., Chicago 22, Illinois

NUGENT FILTERS

Since 1897

AUDELS POWER PLANT ENGINEERS GUIDE
WITH QUESTIONS AND ANSWERS



NEW FROM COVER TO COVER!

JUST PUBLISHED—For All Engineers, Firemen, Water Tenders, Oilers, Operators, Repair Men and Applicants for Engineers' License Examinations.

A Complete Steam Engineers' Library in One Book!
1500 PAGES—65 CHAPTERS
1700 ILLUSTRATIONS. FULL INDEX

1001 FACTS AT YOUR FINGER ENDS!
PRACTICAL INFORMATION IN HANDY FORM FEATURING:

Basic principles of Steam Engineering, including Boiler Construction, Operation and Repairs. Gives practical information on Boiler Calculations, fuels, feed pumps, water heaters, economizers, water treatment, injectors, traps, draught, safety valves, oil burners, stokers, condensers, ejectors, cooling towers, evaporators, steam and hot water heating, pipe fitting & tubing. Contains complete data on all types of Steam Engines and Turbines, Indicators, Valve gear, Valve setting, Air Compressors, Hoists, Gas and Diesel Engine Operation, Lubrication.

$4 COMPLETE

PAY $1 A ONLY MO.

Get this information for yourself—ASK TO SEE IT—Mail coupon today!

AUDEL, Publishers; 49 W. 23 St., New York 10, N.Y.

Mail AUDELS Power Plant Engineers Guide (Price $4) on 7 days free trial. If O.K. I will remit $1 in 7 days and $1 monthly until $4 is paid. Otherwise, I will return it.

Name_____

Address_____

Occupation_____

Employed by_____ PPE

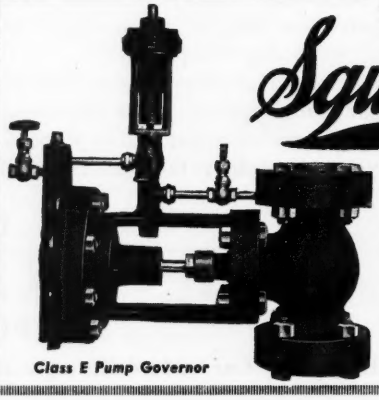
We Originated the Seamless Copper Float

'way back when float users began to be "all fed up" with float failures. Float users looked to Hercules to produce the better float that was so sorely needed, so we did it. Naturally, there are imitations, but there is no satisfactory substitute for Hercules Seamless Copper Floats, as those who have experimented expensively will tell you. Sold under a full year's guarantee. Your inquiries invited.

HERCULES FLOAT WORKS
200 Franklin St. Springfield, Mass.

The Genuine

Squires

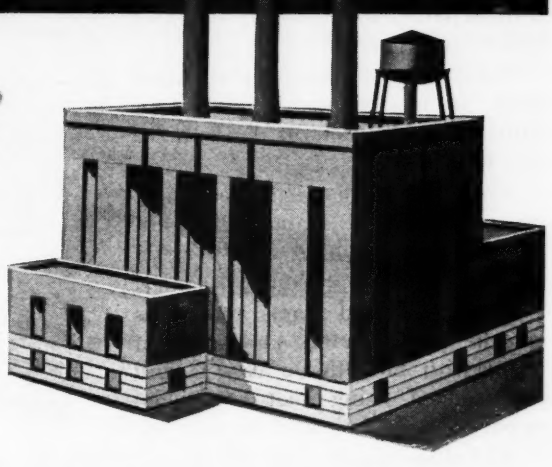


For True Regulation on Boiler Feed Pumps

The C. E. Squires Co.
E. 40th Street and Kelley Avenue
Cleveland, O.
Catalog E-12 explains

Class E Pump Governor

PLANNED ECONOMY begins with TODD BURNERS



SUCCESSFUL, planned economy is not unlike a small boy and his piggy bank.

Every dime saved grows into dollars . . . and dollars into impressive total amounts.

Such savings are entirely possible through the installation of the *right* Todd Burners, which can save you 10¢ out of every dollar spent for oil or gas, in production of power and heat.

At the same time Todd Oil and Gas Burners give you efficient automatic control, adjustable to your power needs, and appreciably increase your power output.

Result: *Reduced cost per pound of steam* leading to lessened operating costs and total plant overhead.

Todd for thirty years has supplied the world with efficiency-tested liquid and gaseous combustion equipment; today there is available to you a *complete* line of *completely* modern Todd Burners, rightly adapted for all power and heat uses in the industrial, commercial and marine fields.

Summon a Todd trained engineer. He'll be glad to go over your specifications with you and explain how modernization with Todd will save you money.

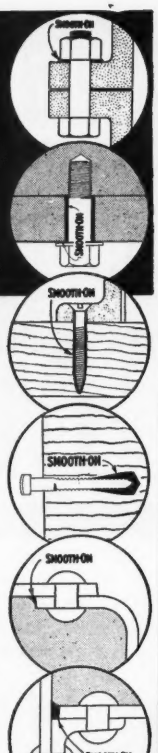
ARMY E NAVY

COMBUSTION EQUIPMENT DIVISION
TODD SHIPYARDS CORPORATION
601 West 26th Street, New York 1, N. Y.

NEW YORK, BROOKLYN, ROCHESTER, HOBOKEN, NEWARK, PHILADELPHIA, SO. PORTLAND, ME., BOSTON, SPRINGFIELD, MASS., BALTIMORE, WASHINGTON, CHICAGO, GRAND RAPIDS, TAMPA, GALVESTON, HOUSTON, MOBILE, NEW ORLEANS, LOS ANGELES, SAN FRANCISCO, SEATTLE, TACOMA, MONTREAL, TORONTO, BUENOS AIRES, LONDON

ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

"Little" Repairs THAT OFTEN SAVE Big Expense



One loose bolt, nut, screw or rivet can cause a breakdown, delayed production, much expense. Caught in time and tightened with

SMOOTH-ON No.1

Iron Repair Cement, the trouble and expense are averted.

Bolts and nuts worn or stripped loose are easily made tight again with an application of Smooth-On No. 1.

Wood screws that have lost their grip, whether set against the grain or wtih it, take hold firmly again when coated with Smooth-On No. 1.

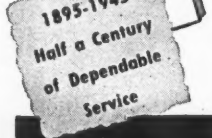
Leaking riveted seams and joints can be made water- and air-tight again with Smooth-On No. 1, and no need of using heat or special apparatus.

And these repairs *last*. Because Smooth-On expands slightly as it sets, filling cracks and crevices and openings tightly, firmly, resistingly.

Get Smooth-On No. 1 from your supply house. If they haven't it, write us. Packed in sizes from 7 oz. up.

FREE 40-page Repair Handbook

Gives clear-cut directions for repairing plant and home equipment of many kinds. 170 diagrams. A book every engineer and mechanic wants—over 1,000,000 now in circulation. Send coupon for your copy.



---Mail This Today---

Smooth-On Mfg. Co., Dept. 31, 570 Communipaw Ave., Jersey City 4, N. J.

Please send me my copy of the Smooth-On Repair Handbook.

Name .....

Address .....

8-45 .....

Do it with **SMOOTH-ON**

The Iron Repair Cement of 1000 Uses

To Protect Boiler Tubes Against Possible Pitting Finish with

MAGIC BOILER PRESERVATIVE

SOME methods of water softening remove calcium and magnesium bicarbonate and calcium and magnesium sulphate, but do not remove certain insoluble salts which accumulate and form a hard scale.

Other methods take out the insoluble salts but introduce an equivalent amount of sodium salts. This may lead to pitting and alkali embrittlement.

In both cases, the safe rule is "Finish with Magic." It provides a colloidal film of protection on the surface of boiler metal that checks scale formation—guards against corrosion and pitting.

WRITE FOR DESCRIPTIVE BULLETIN

GARRATT-CALLAHAN CO.

Established 1904

OF ILLINOIS 59 East Van Buren St. Chicago 5

OF NEW YORK, Inc. 1328 Broadway New York City 1

OF CALIFORNIA 148-156 Spear St. San Francisco 5

FOR SALE

STOKER

One 125 H.P. James Leffel Stoker for use in 125 H.P. Scotch Marine Boiler, complete with 3 H.P. 220 V. 60 Cycle AC three phase motor. Cost new $2800. In use only sixteen months. Any reasonable offer considered. For further information address the

SOLAR COMPOUNDS CORPORATION

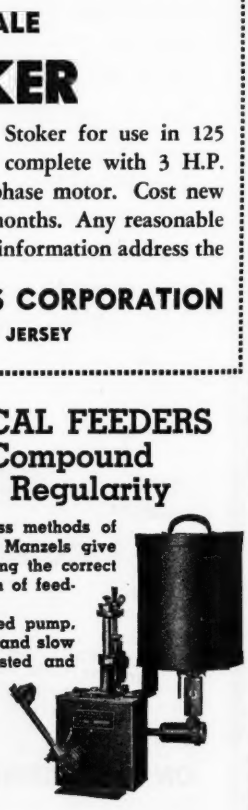
LINDEN, NEW JERSEY

MANZEL CHEMICAL FEEDERS Inject Boiler Compound with Clock-like Regularity

Manzel Feeders make hit and miss methods of injecting boiler compound obsolete. Manzels give the boiler better protection by injecting the correct amount of chemical into every gallon of feedwater.

Installed directly on the boiler feed pump, Manzel Feeders start, stop, speed up and slow down with it. Feed is easily adjusted and once set, the only attention the Feeder requires is to keep the reservoir supplied with chemical.

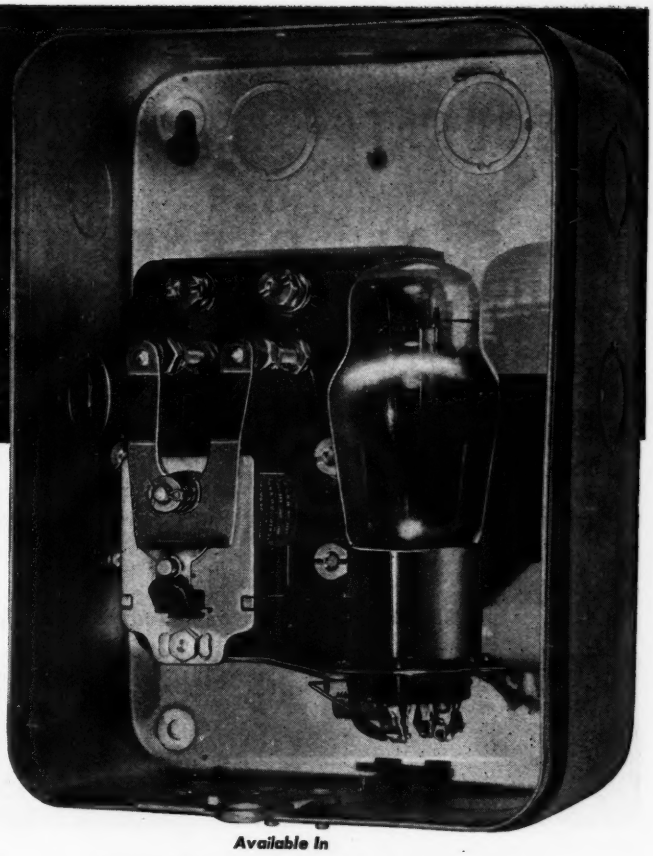
Write for Bulletin.



MANZEL BROTHERS COMPANY
327 Babcock St. Buffalo 10, N. Y.

PRINCO 30 AMPERE *ELECTRONIC* RELAY

CONTROLS LARGE OUTPUTS WITHOUT USE OF AUXILIARY RELAYS



This grid controlled half-wave rectifier combines in one compact unit, all of the functions of a pair or series of relays as commonly used to handle up to 30 amperes output.

Highly sensitive and instantaneous in action, the Princo relay is the result of 10 years research and service experience covering a wide range of applications. Less than 10 watts power are required to operate the circuit.

All parts are replaceable; contact points are easily replaced and adjusted. Design and wiring is simple, making for trouble-free, long service life. Users report over five years service without need to replace electronic tube.

Write today for your copy of Princo Bulletin—which contains complete details on the 30 Ampere Electronic Relay.

Use the Princo 30 Ampere Relay Under These Operating Conditions

1. Where actuating contact resistance is over 5000 ohms.
2. Where speed of response is important.
3. Where actuating contacts are extremely delicate and arcing is detrimental.
4. Where appreciable currents up to 30 amps must be controlled by contact rated in microamperes. (50 ampere relay is also available.)
5. Where actuating contacts do not touch but rather operate due to capacity.
6. Where the actuating device is electrolytic or polarizable and must control large currents.
7. Where alternating current from 50 to 60 cycle frequencies is available.

Available In

SINGLE-THROW, DOUBLE POLE—30 AMP.
DOUBLE-THROW, SINGLE POLE—15 AMP.

For Use With

AC 110-220 VOLT—60 CYCLE
ACTUAL SIZE—5" x 5" x 3¾"
DUSTPROOF HOUSING—6" x 8" x 4"

PRINCO ELECTRONIC RELAYS INCREASE THE SERVICE LIFE OF MERCURIAL THERMOSTATS AND THERMOREGULATORS

Although Princo Relays are today in use with various thermostats and thermoregulators, microammeters, pressurestats, counting devices, door openers, lighting controls, etc., they were designed by Precision Thermometer & Instrument Company specifically for application in conjunction with the Princo Mercurial Thermostats and Thermoregulators.

The maximum life of any Mercury-and-Glass Thermostat may be expected when it is used in connection with Princo Relays!

PRINCO MAKES A COMPLETE LINE OF MERCURIAL THERMOSTATS AND THERMOREGULATORS!

For the highest precision-accurate temperature control, specify Princo thermostats and thermoregulators, companion instruments to the 30 Ampere Relay. Princo controls are uniformly accurate from —67° to +1250° F. Each instrument is precision engineered; individually calibrated; and filled with aeriated triple-distilled refiltered mercury. Special "Combustion" Glass Tubing is used in Princo High Temperature Thermostats and Thermoregulators, and a unique pressure-filling process insures the stability of the mercury column. Complete data on all types available on request.

PRECISION

THERMOMETER & INSTRUMENT COMPANY

PRINCO

PRECISION INSTRUMENTS FOR INDUSTRY

1421 Brandywine Street, Philadelphia 30, Pa.

for ACCURATE MEASUREMENT use *R. S. YEL O BAK MIDGET INDUSTRIAL THERMOMETERS

Flat Bore—Mercury Filled—Engraved Stem are recommended for equipment requiring small armored thermometers and where large industrial thermometers are not applicable, on oil, gasoline and water lines; tanks and stills.

YEL O BAK thermometers are easy to read, because yellow background apparently gives mercury column a deeper shade.

Available as Regular Angle Form, Left Side Angle Form, Straight Form, and Right Side Angle Form. Special Sizes and Ranges made to your specifications and requirements.

*Trade Mark Registered U. S. Pat. Off.

Specialized Testing and Measuring Equipment • *Catalog No. 30*

THE REFINERY SUPPLY CO.

Main Office and Plant

621 E. 4th Street **TULSA 3, OKLAHOMA** Ph. 4-8144, L.D. 581

YOU WON'T FIND A *BETTER, FASTER* WAY TO REPAIR *BROKEN FLOORS*

NEW PLASTIC PATCH SETS INSTANTLY!

No longer is it necessary to close off an area of concrete floor while waiting for newly installed patches to set thanks to INSTANT-USE, a new plastic repair material by Flexrock. Here's the most revolutionary improvement in floor resurfacers to come along in years. The material comes ready mixed and is ready for traffic almost the moment it's put down. It's just the thing for busy industrial floors, platforms, concrete steps, etc.

JUST TAMP SMOOTH! TRUCK OVER!

There is no waiting. Simply shovel INSTANT-USE into the hole or rut—tamp—and your floor is restored to solid smoothness . . . back in service without delay. Tough INSTANT-USE bonds tight to old concrete, makes long-lasting heavy duty patch. Withstands extreme loads. Keep a drum on hand for emergencies. Immediate shipment.

Request Descriptive Folder and Details of

FREE TRIAL OFFER!

FLEXROCK COMPANY
3623 Filbert St., Philadelphia 4, Pa.

Please send me complete INSTANT-USE information and details of FREE TRIAL OFFER—no obligation.

Name.....
Company.....
Address.....

Use

LESS PAPER

Because:

Paper vests have proved excellent for aviators and ground crews as cold protection.

Paper is used for disposable gun covers and ordnance wraps to protect such equipment while making invasion landings.

The Army supplies helmets of laminated fiber for non-combat duty in the tropics.

Many essential airplane parts are fabricated of plastic with a paper base.

Army trucks require 20 pounds of paper for safe delivery.

It takes 25 tons of blueprint paper to make a battleship.

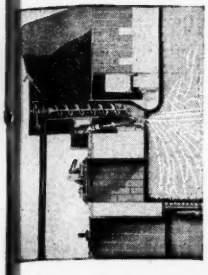
• •

This advertisement prepared under the auspices of the War Advisory Council in co-operation with the Office of War Information and the War Production Board. Space contributed by POWER PLANT ENGINEERING.

FYR-FEEDER MULTIPLE SPREADER STOKERS

BURN COAL LIKE OIL!

ave with FYR-FEEDER—Burn less coal—Cheaper coal—Local coals—Screen-ngs—Coal Yard Sweepings, wet or dry—WET coal is no handicap.



FYR-FEEDER exclusively employs ← air JET coal PROPULSION

Fines burn in suspension, larger pieces are spread evenly over grate.

FYR-FEEDER increases boiler capacity—responds instantly to sudden load variations—requires no special skill or experience to operate—thin fuel bed eliminates clinkers—makes fireman's work much easier—no banking losses.

CHANGE OVER TO FYR-FEEDER NOW

Easily installed in minimum time

YR-FEEDERS are built in sizes to burn from 300 to 12,000 lbs. coal per hour. you are or expect to be in the market for automatic coal burning equipment

Wire or Write
FYR-FEEDER Stoker Division
AMERICAN COAL BURNER COMPANY
Engineers

22—19 E. Erie St. Chicago 11, Ill.

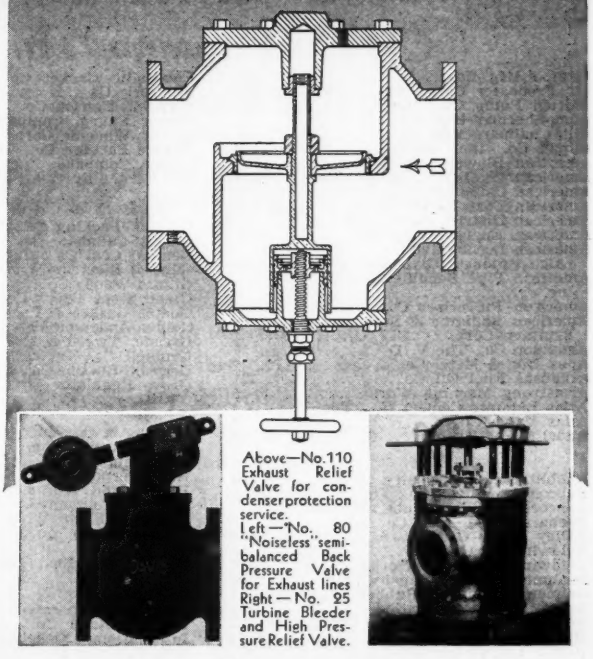
USED EQUIPMENT FOR SALE AT OUR EAST PEORIA STATION 1126 W. WASHINGTON ST. PEORIA, ILL.

1—1392 H.P. Springfield sectional all steel water tube boiler built for 400 lbs. working pressure with Tracy steam purifier, Vulcan soot blowers, 1180 sq. ft. water screen Elesco steam superheater with 1605 sq. ft. of heating surface, temperature raise 250 degrees; 1—1441 sq. ft. Foster economizer with Diamond soot blowers and 1 Green type SA double inlet steel plate induced draft fan complete with 200 H.P. motor and controller. Capacity of unit 160,000 lbs. per hour at 375% of rating.

1—6 ton, 6 roll Raymond vertical mill complete with air separation system including collector, No. 12 exhauster, discharge and return air piping, feeding and burning equipment, all complete with motors and controllers.

CENTRAL ILLINOIS LIGHT CO.
Peoria 2, Ill.

DAVIS AUTOMATIC RELIEF VALVES



Above—No. 110 Exhaust Relief Valve for condenser protection service.
Left—No. 80 "Noiseless" semi-balanced Back Pressure Valve for Exhaust lines
Right—No. 25 Turbine Bleeder and High Pressure Relief Valve.

No Power Plant Valve Is More Important

In 69 years of specialization on power plant automatic valve specialties, Davis has brought the atmospheric exhaust relief valve to a high point of perfection, with a combination of engineering features not found elsewhere.

Let's look inside the No. 110: The bronze-to-bronze contact valve is water-sealed through inlet and overflow pipe connections in the body. Valve action is cushioned by a closed-top internal dash pot eliminating sticking of valve due to foreign matter. Flapper valve permits quick opening, slow closing movement. There is full pipe area through the port and all body passages. The valve holds tight under high vacuum, and relieves to atmosphere at a fraction of a pound pressure when vacuum is lost.

Hand lifts, top or bottom, or Hydraulic cylinders permit testing the action and holding valve open when desired.

Angle design available as well as horizontal and vertical, also valve that will function as a relief valve part of the time and back pressure valve at other times, or with hold-open attachment so that valve must be closed manually once it has relieved.

Let us help you on automatic valve problems for steam . . . air . . . gas . . . water . . . and oil. DAVIS REGULATOR COMPANY, 2508 S. Washtenaw Ave., Chicago, Ill.

Ask for ENGINEERING BULLETIN No. 101A

DAVIS VALVES
DAVIS REGULATOR COMPANY

ADVERTISERS

Airetool Mfg. Co. 184
Air Preheater Corp., The 191
Aldrich Pump Co., The ..... *
Allen-Sherman-Hoff Co. ..... *
Allis-Chalmers Mfg. Co. 26, 57, 169
Allpax Co., Inc., The 162
American Blower Corp. ..... *
American Chain & Cable Co., Inc. 139
American Chimney Corp. 172
American Coal Burner Co. 197
American District Steam Co. 144
American Engrg. Company 44-45
American Locomotive Co. (Alco Products Division) 171
American Pipe Bending Machine Co., Inc. ..... *
American Pulverizer Co. ..... *
American Radiator & Standard Sanitary Corp. ..... *
Anderson Co., The V. D. ..... *
Apex Iron & Metal Co. ..... *
Arkansas Fuel Oil Co. 121
Armstrong Machine Works 14-15
Atlas Lumnite Cement Co., The ..... *
Atlas Valve Co. ..... *
Audel & Co., Theo. 192

Babbitt Steam Specialty Co. 186
Babcock & Wilcox Co., The 28-29
Babcock & Wilcox Tube Co., The ..... *
Bacharach Ind. Inst. Co. ..... *
Bailey Meter Co. 12-13
Baldwin-Hill Co. 156
Baldwin Locomotive Works 117
Beaumont Birch Company 168
Belmont Packing & Rubber Co., The ..... *
Bendix Aviation Corp. 168
Bernitz Furnace Appliance Co. 137
Betz, W. H. & L. D. 30-31
Biddle Co., James G. 132
Bird-Archer Co., The ..... *
Blackmer Pump Co. 188
Blaw-Knox Co. ..... *
Bonney Forge & Tool Works 49
Bowser, Inc. ..... *
Breuer Electric Mfg. Co. ..... *
Brickseal Refractories 176
Bridgeport Brass Co. 153
Briggs Clarifier Co. 138
Brunt Equipment Co. ..... *
Burgess-Manning Co. ..... *

Cash Co., A. W. ..... *
Central Illinois Light Co. 197
Certified Gauge and Instrument Corp. 136
Chapman Valve Mfg. Co., The ..... Inside Back Cover
Chesterton Co., A. 170
Chicago Metal Hose Corp. 126
Cities Service Oil Company 121
Climax Industries (McAlear Division) ..... *
Clipper Mfg. Co., The 178
Cochrane Corporation 34, 170
Combination Pump Valve Co. ..... *
Combustion Control Corp. ..... *
Combustion Engrg. Co., Inc. 20-21
Candenser Service & Engrg. Sorp 159
Connery Construction Co. 180
Cook's Sons, Inc., Adam ..... *
Corning Glass Works 162
Crane Co. 103
Crane Packing Co. 42
Crocker-Wheeler Division ..... *
Cutler-Hammer, Inc. ..... Back Cover

Dampney Company of America, The ..... *
Dart Mfg. Co., E. M. 142
Davis Engrg. Corp. ..... *
Davis Regulator Co. 197
Dearborn Chemical Co. ..... *
De Laval Separator Co., The ..... *
De Laval Steam Turbine Co. 37, 172
Detrick Co., M. H. ..... *
Detroit Stoker Co. 22-23
Diamond Power Specialty Corp. 24-25
Dollinger Corp. ..... *
Dowell, Incorporated 151

Edge Moor Iron Works, Inc. 50
Edward Valve Mfg. Co., The 119
Ehret Magnesia Mfg. Co. 27
Elgin Softener Corp. ..... *
Elliott Co. 2-3, 189
Engineer Co., The 128
Ernst Water Column & Gage Co. 51
Everlasting Valve Co. 182

Fairbanks, Morse & Co. ..... *
Fairmont Coal Bureau 183
Farris Engineering Co. ..... *
Fischer & Porter Co. ..... *
Fisher Governor Company ..... *
Flexitallic Gasket Co. 46
Flexrock Co. 196
Flynn & Emrich Co. ..... *
Foster Engrg. Company ..... *
Foster Wheeler Corp. 32-33
France Packing Co., The 168
Fuller Company ..... *
Fyr-Feeder Spreader Stoker Div. 197

Garlock Packing Co., The ..... *
Garratt-Callahan Co. 194
General Coal Co. 152
General Electric Co. 10-11, 143, 187
Gifford-Wood Co. 167
Globe Steel Tubes Co. 149
Goetze Gasket & Packing Co., Inc. ..... *
Golden-Anderson Valve Specialty Co. ..... *
Greene, Tweed & Co. 146
Grinnell Co., Inc. 135
Griscom-Russell Co., The 125
Grove Regulator Co. 173

Haering & Co., Inc., D. W. 148
Hagan Corporation ..... *
Hall Laboratories ..... *
Hays Corporation, The 105
Hendy Iron Works, Joshua 43
Henszey Company 154
Hercules Float Works 192
Hills-McCanna Co. ..... *
Honan Crane Corp. ..... *
Huyette Co., Inc., The Paul B. ..... *

Infilco, Incorporated 179
Ingersoll-Rand Co. 53
International Nickel Co., Inc., The 145
Iron Fireman Mfg. Co. ..... *

Jefferson Union Co. 164
Jenkins Bros. 147
Johns-Manville ..... *

Keasbey & Mattison Co. 18
Kellogg Co., The M. W. ..... *
Kennedy Valve Mfg. Co., The 131
Kieley & Mueller ..... *

Ladish Drop Forge Co. 133
La Motte Chemical Prod. Co. ..... *
Leavitt Machine Co., The 157
Leeds & Northrup Company 56
Leslie Company ..... *
Link-Belt Co. ..... *
Liquidometer Corp., The 184
Lummus Co., The 38
Lunkenheimer Co., The 101

Manzel Bros. Co. 194
Marion Machine, Foundry and Supply Co. 172
Marley Company, Inc., The ..... *
Maxim Silencer Company, The 6
McAlear Manufacturing Company ..... *
McGraw-Hill Book Co., Inc. 186
Mercoid Corp., The 184
Midwest Piping & Supply Co., Inc. 41
Milton Roy, Pumps ..... *
Mitchell Co., W. K. 160
Murray Iron Works Co. 166

National Aluminate Corp. 174
National Boiler Protector Co. 166
National Valve & Mfg. Co. 161
Niagara Blower Co. 130
Nicholson & Co., W. H. 158
Northern Equipment Co. 111
Norton Company 141
Nugent & Co., Inc., Wm. W. 192

Oakite Products, Inc. 166
Ohio Injector Co., The 129
Otis Elevator Company 48

Patterson-Kelley Co., Inc., The ..... *
Peabody Engineering Co. ..... *
Pennsylvania Crusher Co. 190
Permutit Co., The ..... *
Philadelphia Gear Works ..... *
Phoenix Mfg. Co. 181
Photoswitch, Inc. ..... *
Pipe & Tube Products, Inc. ..... *
Pittsburgh Coal Co. ..... *
Porter Co., Inc., H. K. 160
Porter & Co., Inc., H. W. ..... *
Powell Co., The Wm. 163
Powers Regulator Co., The ..... *
Precision Thermometer and Instrument Co. 135
Pritchard & Co., J. F. ..... *
% Proportioneers, Inc. % ..... *

Quaker Rubber Corporation ..... *
Quimby Pump Co., Inc. 160

Raybestos-Manhattan, Inc. 134
Reading-Pratt & Cady Div. of American Chain & Cable Co., Inc. 139
Refinery Supply Co., Inc. 196
Reliance Gauge Column Co., The ..... *
Rempe Co. ..... *
Republic Flow Meters Co. 52
Richardson Scale Company ..... *
Roto Div. of Elliott Co. 189
R-S Products Corp. ..... *

Sarco Company, Inc. ..... *
Saverite Engrg. Co. ..... *
Scovil Mfg. Co. 109
Schutte & Koerting Company ..... *
Sea-Ro Packing Co. ..... *
Shell Oil Co., Inc. 9
Sier-Bath Gear Co., Inc. ..... *
Simplex Valve & Meter Co. ..... *
Sims Company, The 188
Sinclair Refining Co. ..... *
Skinner Engine Co. ..... *
Smooth-On Mfg. Co. 194
Socony-Vacuum Oil Co., Inc. ..... *
Solar Compounds Corporation 191
Springfield Boiler Co. ..... *
Squires Co., The C. E. 192
Standard Oil Company of California ..... *
Standard Oil Company (Indiana) 35-36
Steel Improvement & Forge Co. 177
Stephens-Adamson Mfg. Co. 55
Sterling Engine Co. ..... *
Stonhard Co. 190
Stout & Sons, David 172
Strong, Carlisle & Hammond 54
Sun Oil Company 113
Swartwout Co., The ..... *
Syntron Company 158

Taylor & Co., W. A. 176
Taylor Forge & Pipe Works 155
Templeton Brothers, Inc. 170
Terry Steam Turbine Co., The 40
Texas Co., The 4
Tide Water Associated Oil Co. ..... *
Todd Shipyards Corporation (Combustion Equipment Division) 193
Treasurey Department ..... *
Troy Engine & Machine Co. 127
Tube-Turns, Inc. 115

Union Iron Works ..... *
Union Asbestos & Rubber Co. 185
Union Chain & Mfg. Co., The ..... *
U. S. Gasket Co. 107
United States Rubber Co. ..... *
United States Steel Corp. ..... *

Victor Products Corp. 186
Viking Instruments, Inc. 178
Vogt Machine Co., Inc., Henry 165

Waldron Corp., John ..... *
Wallace & Tiernan Products, Inc. 140
Warren Steam Pump Co., Inc. 123
Western Chemical Co. ..... *
Westinghouse Elec. Corp. 16-17
Wheeler Mfg. Co., C. H. 188
Wickes Boiler Co., The 188
Wiley & Sons, Inc., John ..... *
Williams Gauge Co., The ..... *
Williams Valve Co., The D. T. 190
Wilson, Inc., Thos. C. 150
Wing Mfg. Co., L. J. 124
Worthington Pump & Machy. Corp. 19

Xzit Sales ..... *

Yarnall-Waring Co. 39, 47, 58

Zurn Mfg. Co., J. A. ..... *

Firms whose advertising is not in this issue but is appearing in other issues are marked with in *

You Can Have Seats or Plugs in Chapman List 960 Small Gate Valves

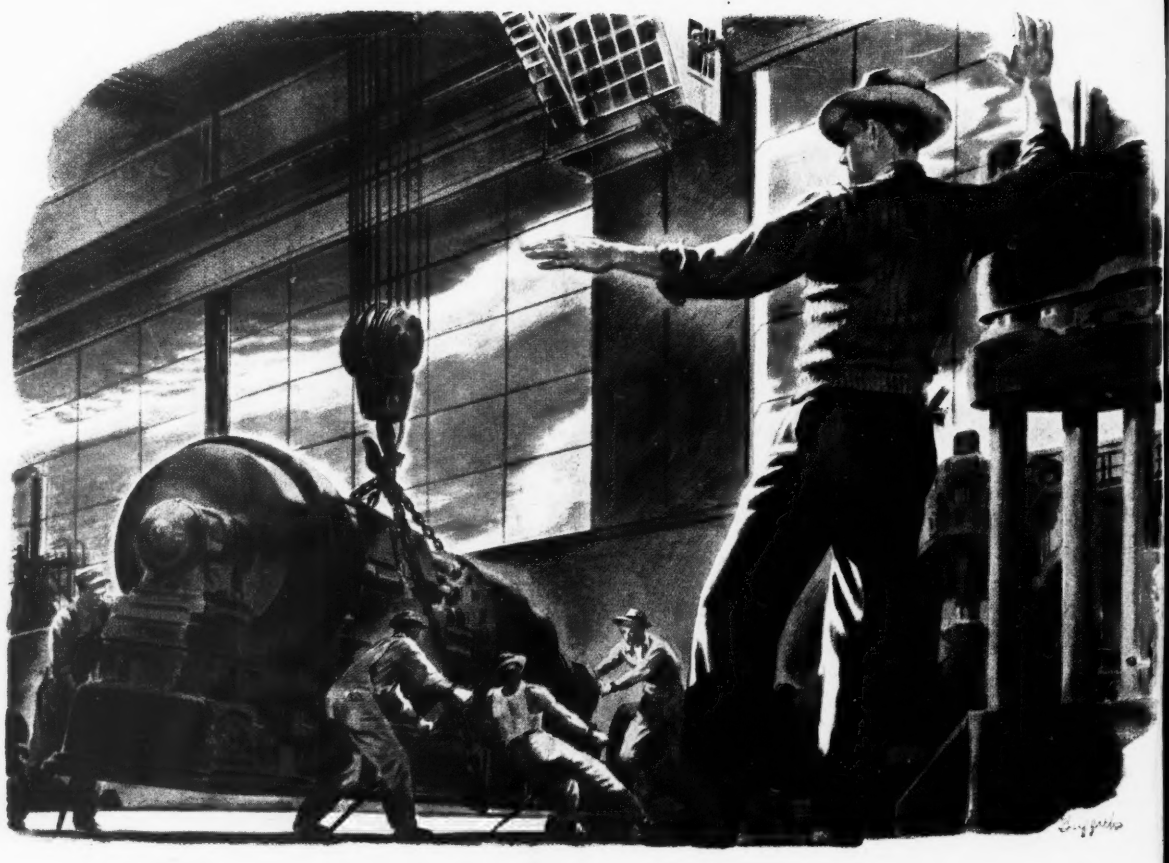
Hard or Super-Hard!

Seats and plugs in the rugged Chapman List 960 can be supplied superhardened for extra severe services. This improved small gate valve has quick-acting threads for fast opening and closing — they will not stick or freeze. As no pressure is transmitted to the stem, the valve can be repacked under full pressure.

Chapman List 960 is made in sizes from 1/4" to 2"— carbon steel for pressures to 800 pounds; alloy steel for pressures to 1000 pounds at 750° F. For higher pressures, specify List 990.

The CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASS.

PATENT 1,866,292



TAKING THE "CAN'T" OUT OF CRANES

New Cutler-Hammer Control avoids need for special power

Years ago, when America's factories first used electric motors, there was only one kind of power available. It was Direct Current, familiarly known as "dc". But this type of current had one serious disadvantage. It *had* to be used within a few miles of the place where it was generated. So engineers turned their attention to Alternating Current, or "ac", which *could* be produced efficiently in great quantities at one point and carried by wires for *hundreds* of miles in every direction to supply power to *thousands* of users. Today, 97% of Industry's electric motors operate on alternating current. The nation is spanned by great "ac" networks. Factories need no longer be jammed into congested districts. Electric power is *everywhere*.

The question might well be asked, "Why do 3% of Industry's electric motors still operate on dc?" It is because certain jobs require very accurate speed control for which all of America's engineers have been unable to find better answers than the direct current motors being used. But the search goes on and on. Until just recently, most overhead traveling cranes simply *had* to have dc. It often meant the installation of special direct current generating machinery or other expensive electrical equipment just to run the crane. There was no other answer to the accurate spotting of crane loads or the smooth lowering of loads . . . until Cutler-Hammer engineers announced one of the most ingenious control systems of all time, Cutler-Hammer AC Crane Control. Now *standard* alternating current motors can be used on cranes. Loads *can* be spotted with precision. Loads *can* be handled with such perfect control through *five* stable dynamic lowering speeds that operators cannot tell the performance from dc. The it-can't-be-done-with-ac tradition has been shattered again. More factories than ever before can now install the cranes they need. And another demonstration of Cutler-Hammer engineering leadership appears on the record for your consideration in the purchase of *any* motor control equipment. CUTLER-HAMMER, Inc., 1392 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

Engineering excellence finds its greatest reward in the respect and confidence of those it serves

CUTLER·HAMMER
MOTOR CONTROL
C·H